COTTON SPINNING

(*INTERMEDIATE OR GRADE II*)

BY

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BEING A COMPANION VOLUME TO "GRADE I COTTON SPINNING" AND "HONOURS, OR FINAL GRADE COTTON SPINNING"

WITH ONE HUNDRED AND TWELVE ILLUSTRATIONS

THIRD EDITION

REVISED AND GREATLY ENLARGED

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PREFACE TO FIRST EDITION.

As stated in the preface to the first volume, one principal object of the three small books on cotton spinning, of which this is the second volume, is to provide handy text-books, definitely arranged, to meet the cotton spinning syllabuses of the City and Guilds of London Institute as at present constructed.

The present volume, of course, takes up the subject of cotton spinning exactly where the first volume leaves off, and carries it to the limits allowed by the syllabus of the second year's course, thus exactly covering the whole of that syllabus and no more. The machines and processes, therefore, treated upon in the present volume are: The silver lap machine, the ribbon lap machine, the comber, the bobbin and fly frames, the cotton spinning mule, and the ring spinning frame.

This volume, therefore, carries the subject so far as to include the final spinning process, both as performed on the intermittent and the continuous systems. It really covers the most complicated machines and motions that we have in connection with cotton spinning, and it is evident that the studies of a second year student must perforce be more strictly mechanical than those of either a first or a third year student.

It will be found that the third, and last, volume of this series of small books takes up the subject where it is left by the present volume, and carries it forward, over all the machines, processes, and appliances covered by the syllabus of the honours, or third year's course.

As stated in the first volume of this series, it may fairly be assumed that the questions set in previous years—especially since the last re-arrangement of the syllabuses—and the official syllabuses of the accredited examining body are the best guides that teachers and students can have.

The present volume, therefore, like the other two, is based on such questions and syllabuses.

While a good deal of the same ground has previously been excellently covered by other writers, there is much information and there are many drawings included in this and the other two volumes not given in any other treatise.

In all three volumes conciseness and brevity of treatment of the subjects have been specially aimed at, as distinct from the more exhaustive treatment exhibited in the present author's treatises on special machines and processes. In this concise and brief treatment it is hoped will be found one of the principal merits of these three volumes. The grateful thanks of the author are due to the gentlemen and firms specified in the preface to the first volume for assistance also with this volume.

It may be added that a large and important educational committee has just been formed, composed jointly of representatives of the Lancashire County Council and County Boroughs. One of the duties of this committee will be to co-operate with the City and Guilds of London Institute, with a view to promoting in the most efficient manner possible the teaching of cotton spinning and cotton weaving. It is evident that such a committee as this ought to have an important influence for good on textile instruction in Lancashire.

THOMAS THORNLEY.

BOLTON, LANCS, 1901.

PREFACE TO THIRD EDITION.

THIS book purports to treat upon that section of cotton spinning which for nearly twenty years has been classed as Intermediate, Second Year, or Grade II. It is the middle one of three books constituting the series.

There are several excellent treatises upon cotton spinning, the distinctive feature of the present series being the selection of old examination questions and giving question with answer.

Since the first edition of this book several years have elapsed and many other examination papers have been set in the subject; from these a careful selection of questions has now been made and added to this book so as to bring it quite up-to-date.

The whole of the book has also been subjected to a thorough revision.

The division of the subject into First Year, Second Year, and Honours, or say Grade I, Grade II, and Final, retained in the present series, has stood the test of very many years and substantially meets the approval of most Education Authorities, although subject naturally to some little differences in exact subdivision of processes.

At the time of writing this preface, for example, the drawframe really forms part of Grade I Course, and the Honours or Final Grade is divided into Sections A and B.

THOMAS THORNLEY.

BOLTON, *October*, 1915.

CONTENTS.

ILLUSTRATIONS.

[Below is reproduced the Official Syllabus of the City and Guilds of London Institute for the Grade II. Course in Cotton Spinning.]

ORDINARY GRADE.

Second Year's Course.

1. The preparation of slivers for combing; the machines used for that purpose; the objects of combing; the construction of combing machines and their action.

2. The mode of producing rovings; the construction and action of the machines used; the functions and operation of the various parts; variations in the construction of the different machines in the series; accessory appliances.

3. The methods of twisting rovings and the essential features of good yarn.

4. The construction and action of the mule; definition of the stages of the entire operation; the functions of the different parts of the machine; the effect of each stage upon the material; the methods of driving mules.

5. The construction of ring and flyer spinning frames and their operation; the principles of their action; the variations in construction of different parts; the bobbins used.

6. Calculations of speed, draft, twist, etc., in connection with the above machines.

[*Below are given typical Examination Papers in the Grade II. Course.*]

CITY AND GUILDS OF LONDON INSTITUTE.

EXAMINATIONS DEPARTMENT.

TECHNOLOGICAL EXAMINATIONS, 1900.

COTTON SPINNING.

Ordinary Grade.—Second Year's Course.

Tuesday, 1*st May*, 7 *to* 10.

Instructions.

The number of the question must be placed before the answer in the worked paper.

Not more than twelve questions to be answered.

The maximum number of marks obtainable is affixed to each question.

Answers should be illustrated, as far as possible, with clear sketches.

Three hours allowed for this paper.

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1. Describe and sketch the roller stands used in a drawing frame. Give full details of their construction and the method of setting the rollers. (26 marks.)

2. Describe in detail the method of weighting the top rollers of drawing frames. What results if they are weighted either too lightly or too heavily? At what point should the greatest weight be applied, and why? (22.)

3. State fully what is the principle of drawing cotton fibres. What are the chief objects aimed at, and what occurs to the fibres at different points in their passage? Do not

give in your answer any further description of the mechanism than is necessary to make the nature of the operation clear. (24.)

4. Describe and sketch the detaching mechanism of a Heilman combing machine. In your description assume the circular combs to have passed through the end of the lap and the fluted segment to be approaching the lap. Then describe fully the action of the parts until the tuft is detached and attached. The cams may be indicated roughly, and need not be accurately drawn. (30.)

5. How is the waste which is taken out of the lap by the circular combs stripped? At which points of the machine does improper setting affect the question of waste? What is the average percentage of waste made? (24.)

6. Describe and sketch the upper pact of a roving spindle and the flyer carried by it. How is the latter constructed, what faults are to be avoided in its construction, and how does the presser act? (26.)

7. What is the use of a traverse motion in a roving frame? Describe the construction of any form with which you are acquainted, and detail the defects arising from the irregular action of the motion. (24.)

8. In a roving frame all the various parts are driven from the jack shaft. What would be the result of changing the twist wheel for a larger one if no other changes were made? Reasons must be briefly given for each part of the answer. (26.)

9. What are the essential properties of good yarn for twist and weft? Give these in the order of importance for each class, and say how the method of preparation affects each property, favourably or unfavourably. (24.)

10. What is spinning? How is it effected? What are the differences in the methods adopted, and which of the latter should give the best results, and why? (24.)

11. Describe in detail the principle of the construction of a mule cop. Distinguish between the various stages of its formation, and state at what point the different parts of the mechanism employed come into operation, describing their functions in brief terms. (26.)

12. How are the rollers of a mule driven from the rim-shaft? How are they engaged and disengaged, and at what points during the cycle of operations? (24.)

13. What is a jacking motion? How is it applied and controlled? Why is it used, and what are the dangers (if any) to the yarn arising from its use? (25.)

14. Describe and sketch the taking-in motion of a mule, and explain its action. (28.)

15. What are the features which fix the gauge of the spindles in a ring spinning machine? Are there any appliances which enable the gauge to be made less, and if so, how are they constructed and how do they act? (24.)

16. Describe the building mechanism of a ring frame spinning on bobbins, and show how the bobbin is built. (24.)

17. Why is the square root of the quotient required in making calculations for the twist, rack, lifter and star wheels in roving frames? Illustrate your answer by the following example: You are making a five-hank, the twist wheel being 28, and want to make a seven-hank. What twist wheel will you require? (25.)

18. A rim shaft is running 800 revolutions per minute. It drives by a single worm a wheel with 40 teeth, which is compounded with a pinion with 18 teeth, gearing into a wheel with 60 teeth on the arbor of which is a crank releasing the belt lever. How many seconds will be consumed in rotating the crank once? (22.)

Ordinary Grade—Second Year's Course, 1901.

Tuesday, 30th April, 7 to 10.

Instructions as given above for 1900.

1. What would happen if an attempt was made to draw a mixture of Egyptian and Dhollerah cotton? Would it be possible to use or set any rollers which would successfully draw such a mixture, and if so why? (23 marks.)

2. Describe in detail the principle of doubling, and say what the chief advantages of this procedure are. How do you calculate the weight of the finished sliver? How many ends would you combine in preparing slivers for coarse and fine counts respectively? (23.)

3. Give a full description of the method of covering the top drawing rollers. What materials are used, and what

faults must be avoided? How are the surfaces renewed when roughened? (24.)

4. How is the comb cylinder of the Heilman machine constructed? How is the top comb constructed, mounted and operated, and at what period is it dropped into the lap? Illustrate with sketches. (28.)

5. When the comb sliver or web is delivered by the detaching rollers, what becomes of it? Describe fully the treatment of the sliver until it leaves the machine, and the parts used. (24.)

6. Why is it necessary in a slubbing frame to use a spindle and flyer? What becomes of the twist thus imparted? Describe the change in the sliver after its passage through the machine. (22.)

7. Describe and sketch those parts only which constitute the lifting motion in a roving frame. Show how it is driven. What effect would an unsteady lift have on the building of the bobbins? (27.)

8. What is the object of the differential motion in a roving frame? Describe its action upon the velocity of the bobbin wheel, and say why it is necessary to curve the outlines of the cone drums. A full answer is required. (27.)

9. Describe the cycle of operations in mule spinning, and say what changes the roving undergoes. (22.)

10. Describe and sketch the drag motion of a mule. What are the relative advantages or disadvantages of the Mendoza and clutch gear with the back shaft? (27.)

11. Describe in detail the construction and effect of the quadrant arm of a mule. What is the result if, at the beginning of winding, it be set too far behind the vertical line? (25.)

12. What is the reason for the angular position of the spindles in a mule? How does it aid spinning, and what would happen if the spindles were set at too great or too small an angle with the vertical? (23.)

13. Describe what takes place between the time when a mule carriage arrives at the end of its outward run and its release after backing-off is completed. (24.)

14. What is the object of a double speed in a mule for spinning fine counts? Describe any motion with which you are acquainted. (22.)

15. Describe any spindle used in ring spinning machinery

with which you are acquainted, and give reasons for any special features of its construction. (23.)

16. How are the thread boards of a ring frame constructed and attached to the roller beam? Describe and sketch any motion with which you are acquainted by which they can be turned up. (25.)

17. In a roving frame the twist wheel has 30 teeth, and drives by a carrier the middle cone wheel with 40 teeth. The end cone wheel has 48 teeth, and gears with front roller wheel with 130 teeth. The front roller is $1\frac{1}{8}$ in. diameter. The spindle driving wheel has 40 teeth, and drives by carrier the spindle shaft wheel with 40 teeth. The spindle is driven by a spindle shaft skew with 55 teeth, gearing with spindle wheel with 30 teeth. Find the turns per inch. (24.)

18. A mule has a rim pulley 18 in. diameter, driving tin roller pulley 10 in. diameter. The tin roller is 6 in. diameter and the spindle wharve $\frac{7}{8}$ in. diameter. What is the comparative speed of spindles to that of rim shaft? (22.)

City Guilds Examinations, 1913.

Grade II.

Tuesday, 29th April, 7 to 10.

Instructions.

Certificates will be issued to those Candidates only who have passed the Examination in Grade I. in the same or in a previous year.

The number of the question must be placed before the answer in the worked paper.

The maximum number of marks obtainable is the same for each question.

Answers should be illustrated, as far as possible, with clear *sketches*.

Not more than *twelve* questions to be attempted.

Three hours allowed for this paper.

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1. Describe in detail the manner in which the draw frame performs its duties of (*a*) making the slivers uniform in weight

per yard, and (*b*) laying the fibres parallel. A full answer is required.

2. Describe the coiler motion of a draw frame, defining clearly (*a*) the relative positions of the coiler tube-wheel and the can, and (*b*) the factors governing the rate of relative movement between these parts of the machine to ensure correct coiling. Illustrate your answer by means of sketches.

3. Fully describe the differences in strength, appearance, construction and general characteristics between combed and uncombed yarn from similar cotton. State how these differences are produced by the combing machine, indicating which sections of its mechanism are responsible for each of them.

4. Describe the action of the feed mechanism of a combing machine, and show by means of sketches the position of the feed rollers relative to the nippers. Describe also how each section of the lap delivered is projected through the nippers for combing.

5. Explain, with the aid of sketches, the method of threading the roving through the flyer of a fly frame, giving full reasons for the course followed at each stage of the operation. State what circumstances require slight variations in the method of threading, and describe how these are made.

6. Describe the various functions performed by the spring pieces of a fly frame, indicating the special features of their construction which are necessitated by the duties required from them.

7. Fully describe the differences in the creeling arrangements, hank of creel rovings, and methods of working generally, on fly frames using single and double rovings respectively. State what qualities of cotton and counts of yarn are usually produced under these systems, stating the special advantages of each for the purposes specified.

8. Sketch the outlines of the top and bottom cone drums of a fly frame, indicating the positions occupied by the cone belt at the commencement and finish of a set of bobbins. Describe the manner in which the outlines of these drums are developed, and how they control the winding tension of the roving at any diameter of the bobbin.

9. State how the essential features of yarn differ when intended for twist and weft respectively. Give reasons for

these differences, and state how each variety is twisted during spinning.

10. Fully describe the manner in which the mule quadrant performs the functions of (*a*) slowering the initial speed of the spindles during the formation of the cop bottom, and (*b*) providing a differential speed for winding the yarn at correct tension on the tapered cop chase.

11. State what changes are usually put into operation by the locking of the faller leg of a mule, and fully describe the manner in which they are effected. You may select for your answer any type of mule with which you are acquainted.

12. State to what extent the taking-in action of a mule is assisted by the long back shaft. Sketch and describe the mechanism which actuates this shaft during the inward movement of the carriage.

13. Describe the mechanism used on a mule for controlling the slack yarn liberated by the unlocking of the fallers at the termination of winding. State what advantages are obtained from the use of this motion, and the circumstances under which it is mostly used.

14. Describe the construction of a modern ring frame spindle, and explain the principles upon which this construction is based. State what circumstances have developed this type of spindle, and the advantages which are obtained from it when using high speeds.

15. State the functions of the thread wires or lappets of a ring frame, and show by means of sketches their position relative to the spindle. Describe fully how the spinning is affected by this position, and what results if it is not maintained.

16. From the following particulars of a fly frame find the correct size of the pinion wheel for driving the sun wheel of the Holdsworth differential motion, assuming the frame works bobbin leading: The twist wheel of 35 teeth drives the middle top cone drum wheel of 40 teeth, and the diameters of the large and small ends of the cone drums are 6 in. and 3 in. respectively. The pinion on the bottom cone drum shaft has 16 teeth, and drives a wheel of 66 teeth on the jack shaft, on the end of which is the pinion driving the sun wheel of 112 teeth. The bobbin wheel in the differential motion has 40 teeth, and drives a wheel of 41 teeth on the end of the long bobbin shafts, on which are the skew gear

wheels of 50 teeth driving the bobbin wheels of 20 teeth. The driving shaft runs at 286 revolutions per minute, the spindles run at 700 revolutions per minute, the empty bobbins are $1\frac{1}{4}$ in. diameter, and the roving contains two turns per inch.

City Guilds Examinations, 1914.

Grade II.

N.B.—This year the Examinations began to be held on Saturday afternoons.

Saturday, 2nd May, 2.30 *to* 6.30 *p.m.*

Instructions.

Certificates will be issued to those Candidates only who have passed the Examination in Grade I. in the same or in a previous year.

The number of the question must be placed before the answer in the worked paper.

The maximum number of marks obtainable is the same for each question.

Answers should be illustrated, as far as possible, with clear *sketches*.

Not more than *twelve* questions to be attempted.

Four hours allowed for this paper.

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1. State briefly the causes which led to the introduction of the ribbon lap machine for preparing laps for combing. Describe the advantages and disadvantages of this machine in practice.

2. Describe, with the aid of sketches, how the "overlap" of the piecing is formed by a combing machine. State the approximate length of the overlap formed by the Heilmann and Nasmith combing machines respectively.

3. Describe the method of construction of the comb cylinder of a combing machine, giving full details of the manner in which the various rows of needles are arranged

and set for (*a*) opening out and straightening the lap fringe, and (*b*) retaining and carrying forward the short fibre.

4. Fully describe the differences in construction, operation, and general characteristics, between the slubbing, intermediate, and roving frames, when used in sequence on the same class of cotton. Give full reasons for the differences described.

5. State what functions of a fly frame are controlled by the ratchet, or star wheel of the change motion, briefly describing how the control is effected in each instance. What would be the effect of an increase or decrease in the number of teeth of this wheel?

6. Describe how the spindles of a fly frame are driven, commencing from the driving shaft. Give full details of the manner in which similar direction of rotation is imparted to both front and back rows of spindles from opposite direction of rotation of the two long spindle driving shafts.

7. State to what extent the amount of twist in rovings would differ under each of the following circumstances: (*a*) different hank rovings made from the same class of cotton, and (*b*) the same hank roving made from different classes of cotton. Give full reasons for these differences in each instance.

8. It is common practice when drawing rovings in the rollers of spinning machines fitted with self-weighted top rollers, to set the drawing rollers a shorter distance apart than the length of the fibre being worked. Give full reasons for this procedure, stating the class of work for which it is most suitable and the advantages derived from it.

9. Describe in detail how the operation of spinning is performed by a mule during the outward movement of the carriage. State which portions of the machine are in operation during this period, describing the functions of each and their effect upon the spinning process.

10. Describe, with the aid of sketches, how the "backing-off" friction of a mule is engaged and disengaged. State what factors govern the duration of the backing-off period, describing how this may be increased or decreased in extent.

11. State the functions of the counter faller wire of a mule and describe its effect upon the yarn during winding. Describe how the action of this faller wire indicates the

existence of imperfect winding tension during the inward movement of the carriage.

12. Describe how the driving of mules is usually effected from the line shaft, stating which portions of the machine are independently driven. State your opinion of the advantages and disadvantages of duplex driving as compared with the single drive, giving full reasons.

13. State at what positions during the build of a bobbin on the ring frame the yarn is subjected to the greatest strain during winding. Give full reasons, and illustrate your answer by means of diagrams.

14. Sketch and describe the "copping motion" of a ring frame, giving full details of the manner in which it controls the formation of the bottom cone of the bobbin.

15. A mule spinning from an 11-hank double roving has an actual draft in the rollers of 10. The front roller is $1\frac{1}{8}$ in. diameter, and makes $16\frac{1}{2}$ revolutions per stretch. The stretch is 64 in. Find counts spinning.

16. A comber of eight heads is supplied with laps of 11 dwts. per yard. The length of lap fed per nip is ·22 in. The machine works at 90 nips per minute, and extracts 20 per cent. of waste. Find weight produced per week of both sliver and waste, assuming the machine to work 52 actual hours.

For City and Guilds Examinations, 1915, Grade II., *see* page 296.

CHAPTER I.

THE COMBING PROCESS.

PREPARATION OF LAPS FOR COMBING.

Q. 1890. To produce the laps used in combing, what machines are necessary, and what is the principle of their action?

A. After leaving the carding engine the older method of procedure for the cotton for single combing would be: 1st, passage of drawing frame; 2nd, sliver lap machine; 3rd, comber. In many cases the practice has been altered as follows: 1st, sliver lap machine; 2nd, ribbon lap machine; 3rd, comber.

In double combing the above processes would be performed twice over, as follows:—

Method I.—1st, one head of drawing.
2nd, sliver lap machine.
3rd, combing machine.
4th, sliver lap machine.
5th, comber.

With the introduction of the ribbon lap machine for double combing the order would be as follows:—

Method II.—1st, sliver lap machine.
2nd, ribbon lap machine.
3rd, comber.
4th, sliver lap machine.
5th, ribbon lap machine (optional).
6th, comber.

In any case the sliver lap machine is used in order to convert from 14 to 20 slivers into a narrow lap ready for the comber or for the ribbon machine, when the latter is adopted. The drawing frame is used in order to prepare the fibres for the combing process, as is also the ribbon machine. The latter machine also produces a lap more uniform in

thickness all across the width, so that the nippers of the comber can grip the whole of the sheet of fibres firmly. The slivers put up at the sliver lap machine have a tendency to show individualisation in the lap from the front, and at the ribbon machine the laps are drawn out, and then placed upon each other, so as to effectually destroy the individualisation.

The using of either the draw frame or the ribbon machine makes the fibres parallel and the sheet of cotton more uniform, and in this way assists the action of the comber.

In Method I. sometimes the draw frame is used twice over in double combing.

Sliver Lap Machine or Derby Doubler.

It is generally considered that the sliver lap machine is an indispensable adjunct to the Heilman comber. Anyone who is familiar with the old Derby doubler, as formerly used so very extensively in connection with double carding, can very readily understand the sliver lap machine. The latter, however, possesses leather-covered drawing rollers, which were not used in the Derby doubler—at any rate, to the writer's knowledge, and he formerly had the opportunity of handling and watching quite a number of these machines. Although drawing rollers are used on the sliver lap machines, there is usually only a very small draft in them—as a matter of fact, scarcely enough to warrant their use, say about 1·6. In some makes of these lap machines the back sliver table is maintained of the triangular shape which was always used in the Derby doubler, while in other cases only a rectangular back plate is used. Such a plate is permissible on account of the small number of slivers passed through the machine together as compared with the Derby doubler. Often the writer has witnessed about 60 slivers working together on the older machine, as compared with about 18 or 20 commonly used on the sliver lap machines. The essential use of the older machine was to convert slivers from the breaker card into laps for the finisher card, and in like manner the essential use of the sliver lap machine is to convert the card slivers into narrow laps for the comber. This, of course, is necessary whether the ribbon machine is used or not. The name of the machine indicates its use, as it is fed with slivers of

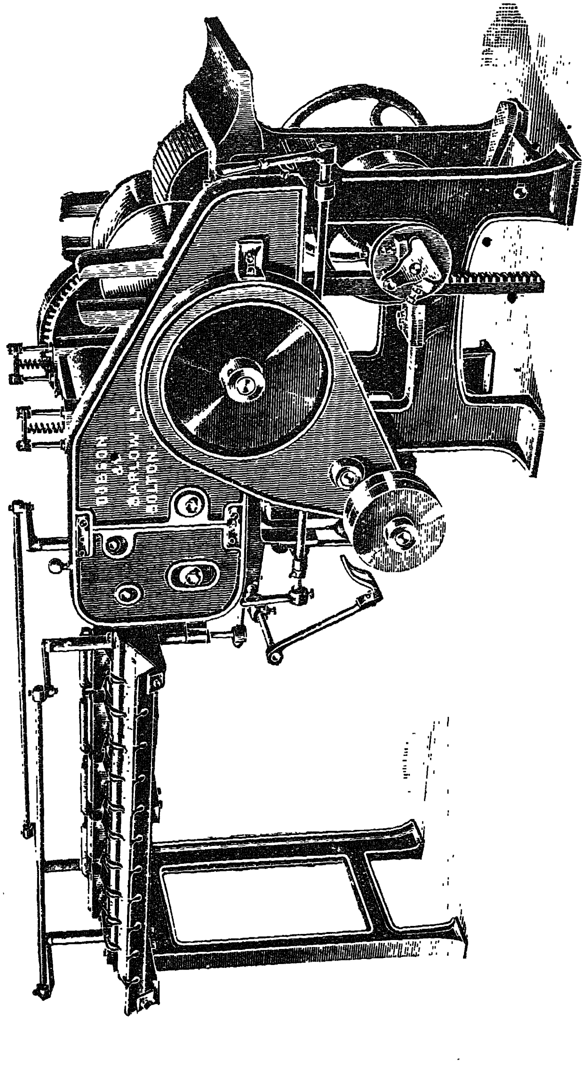


Fig. 1.—The Sliver Lap Machine.

cotton, and it delivers lap. Fig. 1 is a general view of the machine with triangular feed table.

The Ribbon Lap Machine, or Draw and Lap Machine.

The name of this machine very well indicates the object of its use.

It is fed with and delivers thin narrow sheets of cotton, which may be termed ribbons of cotton.

Unlike the sliver lap machine, the ribbon machine is not absolutely essential. It was introduced twenty-five years ago, and was only very slowly adopted for some years.

Recently, however, the introduction of the Nasmith comber, and the tendency to use thicker and heavier lap sheets at the comber, have helped the demand for the ribbon lapper, and it has been much improved in constructional detail.

Recent constructional alterations may be understood from the explanations given below, in respect of the machine made by Messrs. Dobson & Barlow.

In re-designing the machine, the greatest care has been exercised in obtaining absolute accuracy of detail, and where-ever possible, the various parts are machine tooled, and constructed to template, so that there need not be any fear about the parts fitting together nicely and evenly.

It is very desirable that the machine should be absolutely rigid, and to achieve this the makers have arranged the frame end at the driving end of a similar pattern to that on the fly frame, the driving wheels being carried inside the body of the frame end, the panels of which act as a first-class guard for the wheels.

The design of the roller stands and lap carrier brackets has been improved. Further, the machine generally is so arranged that the laps can be placed in position either from the back or the front.

The stop motions, which are quite positive in their action both in regard to the lap at the back running out, and the motion to act when the required diameter of lap has been made by the machine, are a great improvement upon what was previously supplied.

The front curved plates are made of steel stampings of an improved design, and the tables are also made of steel. The

calender rollers on the table are driven positively by gearing with the wheels on the inside of the frame, whilst the driving shaft is at the back of the machine, quite clear of the roller weights, and same is cased in.

At the lap end are two pairs of 6 inch calender rollers driven positively by gearing, and running in ball bearings, the weighting being obtained by means of a lever arrangement with sliding weight.

The lap spindle also runs in ball bearings, and is furnished with a patent locking device which is the acme of simplicity, as well as being perfectly effective in its action, thus dispensing entirely with the troublesome worm and nut.

The brake is of a specially improved design, consisting of a steel band, and connected with the brake lever is a compensating motion, which automatically reduces the amount of "brake" on the lap as the same increases in diameter.

Where requisite, the gearing consists of cut wheels which are perfectly guarded, and the machine runs sweetly, easily, and silently.

If desired, a weight lifting motion can be applied to each delivery, although this is not supplied unless it is specially ordered.

Notes.

Power.—1 m.h.p.

Production.—450 to 500 lb. per day, according to class of cotton.

Speed.—Driving pulley, 14 in. × 3 in.; 262 revs. per minute.

Floor Space.—14 ft. 6 in. × 4 ft. 6 in. = 4,42 m. × 1,372 m.

Approx. Weights.—Machine without weights, gross, 43 cwt.; net, 32½ cwt.; approx. cubic measurement, 140 ft.

Approx weights only, gross, 9¼ cwt.; net, 9 cwt.; approx. cubic measurement, 6 ft.

Strapping required.—Line shaft to machine, 27 ft. × 3 in.

The makers supply, free of charge, with each machine, 1 ordinary top roller or 2 loose shells when loose boss top rollers are used, and the following changes, including those on the machine: 3 draft wheels.

The ribbon machine has for its particular aim the making of laps which are more homogeneous in the sheet than can be got

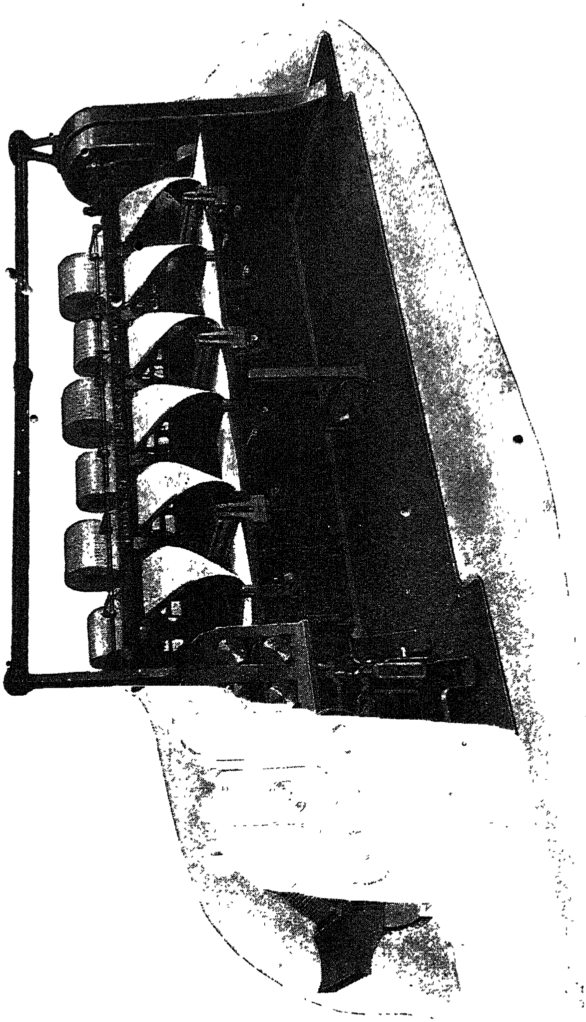


Fig. 2.—The Ribbon Lap Machine.

by any other means, and in this way the needles of the comber can be made to act more effectively on the fibres. Those who have given a little study to the action of the comber, and have witnessed the close combined action of the nippers and the cylinder needles, can readily comprehend the importance of presenting a perfectly even ribbon of cotton to such action. If the ribbon of cotton is a little thicker at one point than another it follows that good fibre may be plucked from between the nippers at the thinner portions of the ribbon. It is the writer's opinion that the ribbon machine does undoubtedly give a more level and homogeneous lap. At the same time, the fact cannot be denied that in many cases a good deal of trouble has been caused owing to the sensitiveness of the ribbons at the front of the ribbon machines and their tendency at this position to make waste. This is one reason why some people have refused to adopt the ribbon machine. It must be understood that the ribbon machine is not an extra machine, since by its adoption no drawing frame is necessary before combing, which otherwise is the case.

The cotton sheet has a decided tendency to spread out in width in passing through the ribbon inactive, and the laps from the sliver lapper need to be about 1½ in. narrower than the comber requires in order to allow for this when the ribbon machine is used.

THE COMBING PROCESS.

Q. 1896. What is the purpose of combing cotton? How is the yarn affected by the process?

A. The chief purpose of combing is to separate the short fibres from the long. All fibres below a certain length are rejected, and pass to the back of the machine into tins as waste, and a practical man, not accustomed to the combing process, would be astonished to see how rapidly these tins fill with waste. An average of the waste made at the comber may be taken at about 18 or 20 per cent., which is as much, or more, than made at all the other machines in the mill put together. The good cotton passes in the form of a sliver into an ordinary card can at the end of the machine. Combing is also the most effective process ever invented for clearing the cotton of small impurities, such as nep, etc. The machine was invented by Heilman,

of Mulhausen, in 1851, and is indispensable in the production of the finest qualities of yarn, although it is a somewhat expensive process. The effect of combing upon the yarn is that it is made very much stronger, because all the short, weak fibres have been extracted. The yarn is cleaner on account of the fine impurities being effectively taken out of the cotton. Also the yarn is possessed of a greater lustre, because of the extremely parallel order to which the fibres are reduced by the combing process. The sliver from the comber is often irregular, and hence the necessity of using the draw frame after the comber in order to get a uniform yarn. If it were not for the use of the draw-box on the comber the sliver would be much more uneven.

Q. 1897. Describe the construction of the combs used in a combing machine. How are they fixed in position, and how do they act?

A. In the combing machine there are the top combs and the bottom or circular combs, the latter being the more important. In a Heilman single nip comber there may be seventeen rows of needles on the periphery of the cylinder, graduated in fineness from about twenty to the inch in the front row to over eighty in the back row, the top comb having usually between sixty and seventy needles to the inch. The circular needles are fastened in the "half-lap," which is itself secured to the comb stock, and can be taken off when necessary for repairs to the combs, etc.

The action is as follows: While the cotton is held by the nippers the circular combs pass through the front ends of the fibres and comb out impurities and short fibre, and carry them to the back of the machine, where they are stripped by a circular brush and doffer. These needles having passed through the fibres, the nippers open, and the fluted segment of the cylinder comes round, and, in conjunction with the detaching rollers, takes the fibres forward. In the meantime the top combs have descended into the fibres, and the front ends of the fibres being pulled forward as described, their rear ends are pulled through the top combs. In this way the front ends of the fibres are first combed and then their rear ends. The objects of the machine are to take out short fibre, to make the fibres parallel, and to take out any leaf, nep, etc., that may have passed the preceding stages. It is important to note that the circular combs revolve and pass

through the fibres, while the latter are mostly held fast at one end, while in the case of the top combs exactly the opposite action takes place—that is, the combs are stationary while the fibres are pulled through them.

Q. 1901. How is the comb cylinder of the Heilman machine constructed? How is the top comb constructed, mounted and operated, and at what period is it dropped into the lap? Illustrate with sketches.

A. Referring first to the cylinder, this is composed of the needle segment, the fluted segment and the making-up pieces. In a single nip comber it has become the standard to employ 17 rows of needles in each segment. The barrel or comb stock is specially constructed so as to permit of the proper attachment of the needles, which are fixed or embedded in a metallic bed termed often the half-lap. Of the 17 rows of needles the fineness and closeness of setting of the needles vary with the different rows, the coarsest needles attacking the cotton first. In the first few rows there may be, for instance, as few as 20 needles per inch of width of the cylinder as compared with upwards of 85 needles per inch in the last row or two, the counts of wire varying accordingly.

Referring now to the top comb, this is mounted above the fibres, being loosely placed upon a shaft which runs the full length of the comber, and by which they are lifted simultaneously from cams fixed on the cylinder shaft. Each comb is, however, capable of being lifted independently of the others for cleaning, piecing-up, and other purposes. It has usually a single row of combs of about 63 needles per inch. The top comb may be allowed to drop by its own weight into the cotton fibres at about $5\frac{1}{2}$ of the index wheel. There are setting screws and brackets by which the amount of lift, the angle and the depth of fall of the top comb can be regulated as may be required.

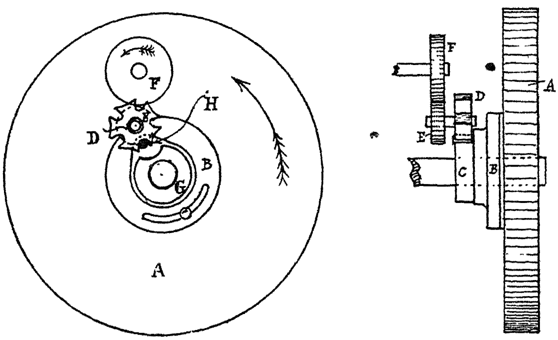
Q. 1899. Describe and sketch the feed mechanism of a Heilman combing machine, and say how much cotton should be delivered by each movement of the feed roller.

A. Adjustably secured to the inside face of the index wheel, and therefore to the cylinder, is a specially shaped cylindrical plate or disc, carrying one feed peg in a single nip and two feed pegs in double nip comber. Taking the single

nip there is only one peg, and therefore at each revolution of the cylinder this peg moves a star wheel of five notches forward to the extent of one notch or tooth, the star wheel thus making one revolution for every five nips. On the same stud as the star wheel is the feed change pinion of, say, about eighteen teeth, and this gears into and drives the feed roller wheel of about thirty-eight teeth. The latter is fixed on the bottom feed roller of, say, $\frac{3}{4}$ in. diameter. The amount delivered per nip may be from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. as proved by the following actual working dimensions :—

One feed peg, star wheel with 5 notches, 18 change pinion, 38 feed roller wheel, $\frac{3}{4}$ in. diameter or feed roller.

$$\frac{1 \times 18 \times 3 \times 22}{5 \times 38 \times 4 \times 7} = \cdot 223 \text{ in.}$$



3*a*. FIGS. 3*a* and 3*b*. 3*b*.

Referring to Figs. 3*a* and 3*b*, A is the index wheel, B, C form the cylindrical disc carrying the feed peg H, which moves the star wheel D, one tooth or notch at every revolution of the cylinder. The feed change wheel E, on same stud as the star wheel D, drives the feed roller wheel F.

Q. 1900. How is the waste which is taken out of the lap by the circular combs stripped? At what points of the machine does improper setting affect the question of waste? What is the average percentage of waste made?

A. The parts concerned in the stripping and disposal of the waste are the circular brush, circular doffer, doffer comb

and receptacle for the waste. The brush revolves at a very rapid rate, and sweeps and brushes the waste from the cylinder needles.

The doffer takes the waste from the brush in much the same manner that the doffer of a card takes the cotton from the cylinder. It has a very slow revolution, and its teeth are set opposite to the direction of revolution of the brush. Again, the doffer comb strips the doffer as on a carding engine. The waste then falls into proper tins, some of which contain a slowly revolving shaft, whose object is to wind the cotton round in a muff form.

Too much waste might be caused by the following:—

(1) Too great an angle in the top combs.

(2) The leather cushion of the nipper being irregular.

(3) The nipper closing too late.

(4) The nippers and other parts not being set parallel

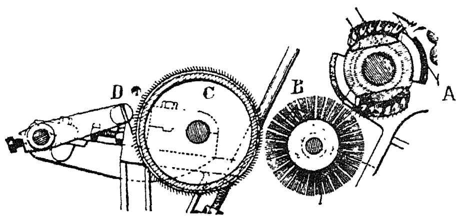


FIG. 4.

(5) The feed rollers acting too late.

(6) The setting of such parts as the top comb being too close.

(7) The back laps being irregular in thickness.

(8) Imperfect arrangement of the fibres by previous machines.

The percentage of waste taken out varies greatly with different firms, but a good average may be taken at about 17 or 18 per cent.

In Fig. 4, A is the cylinder, B is the revolving brush which sweeps the waste from the cylinder needles, C is the doffer covered with strong short wire teeth set so as to receive the waste cotton from the brush B. The doffer comb, D, strips the waste from the doffer and allows it to fall into suitable receptacles.

The Quadrant and Clutch-Box Mechanism.

The construction and action of this arrangement may be understood from the following short description aided by the gearing plan Fig. 9.

There are two cams concerned—one for driving the quadrant upwards and downwards, and the other for opening and closing the roller box.

The roller clutch-box remains closed during the whole of the downward or delivery stroke of the quadrant, but is opened by the small clutch cam on the left of Fig. 9 when the quadrant reaches the bottom of its stroke. At a point somewhere near the middle of the upward stroke of quadrant the roller box is again closed by its cam and remains closed until the quadrant again reaches the bottom of its stroke. In this way we get a forward or delivery rotation of the rollers, the required proportion greater than the return or backward stroke.

Assume the long steel detaching roller to be $\frac{15}{16}$ inch diameter, the wheel on this roller, driven by the quadrant to contain 14 teeth, the quadrant to move the wheel 12 teeth on the down stroke and $5\frac{1}{2}$ teeth on the up stroke, we are required to determine the net length of cotton passed forward at every complete action :—

$$\frac{15 \times 22 \times 12}{16 \times 7 \times 14} = 2{\cdot}52 \text{ inches delivered per nip.}$$

$$\frac{15 \times 22 \times 5{\cdot}5}{16 \times 7 \times 14} = 1{\cdot}15 \text{ inches returned per nip.}$$

$$2{\cdot}52 - 1{\cdot}15 = 1{\cdot}37 \text{ inches net gain.}$$

A practical method of obtaining such answers is to place narrow strips of writing paper between the rollers and carefully mark extent of movements, backward and forward, by a sharp pencil.

Q. 1896. Describe the action of the attaching and detaching mechanism of a Heilman combing machine with single nip. How would you set these parts to comb either Egyptian or Sea Islands cotton?

A. The attaching and detaching mechanism consists chiefly of three rollers of small diameter acting in conjunction with

the fluted segment of the comb cylinder. As it is a single nip machine there is only one fluted segment in the circumference of the cylinder and only one set of needles. One of the three small rollers is termed the "steel detaching roller," and receives an intermittent motion from a cam placed in the headstock at the end of the machine. Another of the rollers is termed the "leather roller" or "top detaching" roller, and it is covered with leather. The third roller is of sufficient weight to nip the fibres firmly. These three rollers have a most peculiar movement, and after the needles of the comb cylinder have passed through the fibres they act with the fluted segment and detach the combed portion of cotton from the nippers, and, passing it forward, attach it to the portion of cotton already operated upon.

The fluted segment of the cylinder comes below the fibres as soon as they are combed, and upon this, while revolving at the same surface speed, is lowered into contact the leather detaching roller. The combed fibres are by the action of these two parts drawn from the jaws of the now open nippers in such a manner that the rear ends of the fibres are drawn through the top comb which has just been lowered into the path of the fibres. By the ingenious reversing arrangement of the rollers, termed piecing, the combed cotton comes out in front of the machine in the shape of a sliver, and is passed out at the end of the machine through drawing rollers and into an ordinary card can. The waste passes out below and at the back of the machine.

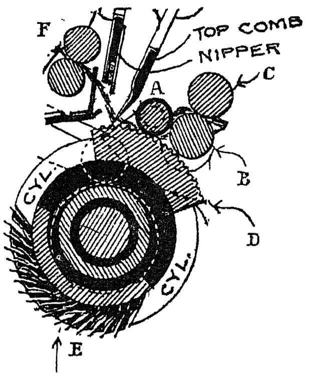


FIG. 5.

Before setting the parts we should see that the leather rollers are recovered if necessary and have all the fluted segments and fluted rollers well cleaned. In setting, certain gauges of definite size are used, and there must be a definite and regulated distance between the flutes of the detaching roller and the front edge of the segment, and also

between the flutes of these two parts when set opposite to each other. The detaching roller must also be set a proper distance from the nipper, knife and cushion plate, and also the feed rollers. Care should be exercised so that the flutes of the top detaching roller are parallel to those of the fluted segment.

For long Sea Islands cottons the distance between flutes of detaching roller and feed roller might be $2\frac{1}{16}$ inches and $1\frac{13}{16}$ inch for Egyptian cotton. For the long staple we might set $1\frac{7}{16}$ inch from flutes of detaching roller to front edge of cushion plate and $1\frac{3}{16}$ inch for Egyptian cotton.

In Fig. 5, A is the leather-covered detaching roller, C is the short top steel roller or piecing roller, B is the long steel detaching roller which gives rotary motion to A and C by frictional contact, D is the fluted segment of the cylinder which acts in conjunction with the detaching rollers, E are the needles of the cylinder, and F are the two feed-rollers.

Q. In a given number of nips a comber makes 240 grains of good sliver and 48 grains of waste. What is the waste per cent?

A. $\frac{100 \times 48}{288} = 16 \cdot 6$ per cent.

Q. 1900. Describe and sketch the detaching mechanism of a Heilman combing machine. In your description assume the circular combs to have passed through the end of the lap and the fluted segment to be approaching the lap. Then describe fully the action of the parts until the tuft is attached and detached. The cams may be indicated roughly, and need not be accurately drawn.

A. As the fluted segment of the cylinder approaches the last combed tuft of cotton fibre the nippers open and the top comb descends into the path of fibres. The three detaching rollers begin to return the rear end of the previously combed and detached fibre. When the fluted segment comes round it begins to take round and detach the newly combed cotton, being assisted by the leather roller, which by this time, having completed its backward motion, is now resting on the fluted segment and has commenced its forward motion. These two parts carry the cotton forward and attach it to the returned portion of cotton and then give all the cotton to the steel

detaching rollers, when the detaching and attaching of the cotton may be said to be completed.

Whether in the case of the notch wheel system of operating the detaching rollers, or in the case of the newer method of doing this work by means of a clutch-box and quadrant, there are several cams required for the various and complicated motions of these rollers. In the case of the quadrant motion the clutch-box would have to be closed by its proper cam during the operation of the detaching mechanism.

Q. 1899. At what points in a combing machine of the Heilman type is there a draft in the cotton? How are the combs fixed and arranged as to fineness?

A. The chief points on a Heilman comber where draft is put in are (1) between the steel feed rollers and the first calender's rollers on the front sliver table; (2) between the front and back rollers on the drawbox. There are several other places where there may also be a slight draft, as between the first calender rollers and the back rollers of the drawbox; between the front roller of the drawbox and the block rollers; between the block rollers and the coiler top rollers; between the wooden and steel feed rollers. The two chief drafts may each equal $5\frac{1}{2}$ to $6\frac{1}{2}$ or so.

As regards the combs, there may be seventeen rows of needles in a single-nip Heilman cylinder, graduated in fineness from between twenty and thirty to the inch in the front rows to over eighty per inch in the back rows. The back needles are thicker and stronger than the front needles, and the coarsest needles pass through the cotton first and the finest needles last. The needles are fixed in a special foundation of metal, which is ingeniously secured to the comb stock, so as to give the needles a correct forward angle.

Q. 1898. Describe the nipping mechanism of a Heilman comber. How are the nippers operated?

A. The nippers of a Heilman comber consist of top and bottom jaws, which alternately open and close. While they are open the cotton is projected through them to perhaps the extent of $\frac{1}{4}$ to $\frac{3}{8}$ of an inch at a time. Then they close and grip the cotton firmly, while the needles of the revolving cylinder pass through the cotton and comb out any short fibres not held by the nippers. This alternate opening and closing may occur between eighty and ninety times per minute in a modern single-nip comber and upwards of 120

times per minute in a duplex comber. The action is effected by a cam on the cam shaft, through the medium of certain rods, levers and springs. As the cam revolves it alternately raises and depresses one end of a lever, whose other end gives corresponding motion to screwed upright rods at the back of the machine. From these upright rods all the peculiar action of the nippers accrues, the top nipper in some part giving motion to the bottom one.

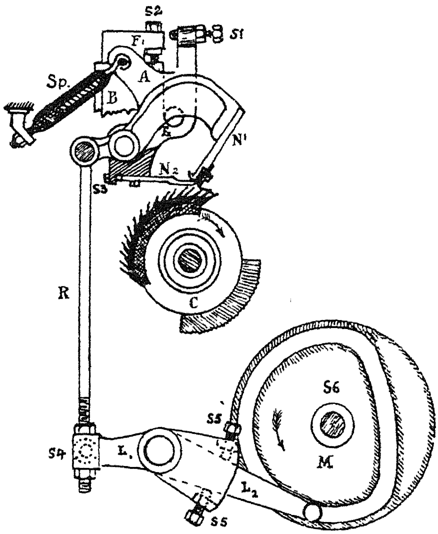


FIG. 6.

Referring to Fig. 6, N^1 is the top nipper and N_2 the bottom one, or, as it is often termed, the cushion plate; C is the cylinder. The motion of the nippers arises from the cam, M, fixed on the cam shaft, and is transmitted to the nippers through the medium of the lever, L_1, L_2, and the screwed upright rod, R.

The nippers are sustained in a swing frame or cradle, A, fulcrumed in the nipper stand, F, B; S1 is the setting point for the upward motion of the cushion plate; S2 is the setting point for distance of nippers from cylinder needles; S3 is the setting point for getting the cushion plate parallel with

the top nipper; S4 is related to S2 in its setting duties; S5 enables several nippers to be set at the same time; S6 is the cam which is adjustable so as to regulate the timing of the nippers. The nippers are shown closed, with the cylinder needles passing through the cotton held by the nipper.

Section of Improved Comber.

Fig. 7 shows a section of the Heilmann comber as made by Messrs. Dobson & Barlow.

Passage of Cotton through the Comber.

The lap is placed on the fluted wooden lap rollers, and the cotton passes down a smooth convex guide plate to the feed rollers, F, F, and through the nippers H, G, and the top comb. D, D, E, are the three detaching rollers, of small diameter, which at the proper time conduct the cotton from the opened nippers to the calender rollers on the front table.

During actual combing the nippers are closed so as to firmly hold the cotton while the needles of the cylinder, A, pass through the cotton. At this time the feed of the cotton by the feed rollers and its delivery by the detaching rollers are suspended. The top comb is lifted up out of the way of the other parts. The cylinder needles do not comb the rear ends of the fibres. After combing is finished the fluted segment of the cylinder and the three detaching rollers take the cotton forward, and at the same time pull the back ends of the fibres through the needles of the top comb. At the same time feeding of the cotton by the feed rollers is taking place.

Supplement to Chapter I. February, 1915.

Since the previous edition of "Grade II. cotton spinning" there have been several Annual Official Examinations in cotton spinning, and many fresh questions have been asked which cover ground not covered in previous editions of this book.

A careful selection has been made from these questions, full answers have been prepared, and these are now hereafter added to Chapter I.

During the last dozen years the Nasmith comber has

been very extensively adopted, and a description of this machine will be found in this supplement.

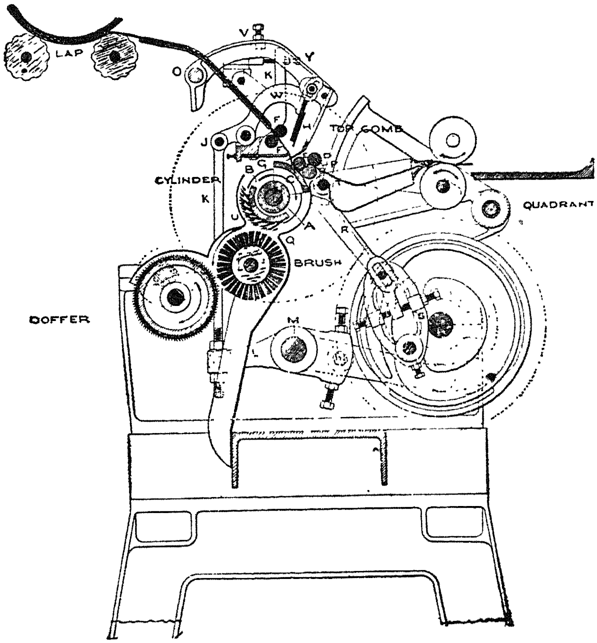


FIG. 7.

Index of Parts.

A Cylinder Shaft.
B, B Half-lap.
C, C Fluted Segment.
D, D Fluted detaching Rollers.
E Leather detaching Roller.
F, F Feed Rollers.
G Cushion Plate.
H Nipper Knife.
J Nipper Arm fulcrum
K Upright connecting Rod for Nipper Arm.
L Nipper Shaft Lever.
M Nipper Shaft.
N Lever for Nipper Cam.
O Top Comb Centre.
P Loose Clutch Wheel.
Q Cylinder Casing.
R Long Lifter.
S Ring for Long Lifter.
T Long lifter Shaft.
U Brush Casing.
V Top Comb setting Screw.
W Nipper Frame Centre.
X Quadrant Bowl or Runner.
Y Nipper setting Screw.

The Whitin comber—introduced from America by Messrs. Howard & Bullough—is also very briefly described at the end of the chapter.

Q. 1909. What differences exist between the drawing of combed and carded slivers on the drawframe? What effects have these differences on the machines in practice? 24 marks.

A. It is well known that we expect the drawframe to improve the work in two principal directions, viz. (1) to produce more equal slivers and thus give more uniform yarn.

(2) To straighten out the fibres and make them much more parallel, and thus to impart lustre and strength to the finished yarn.

Now a comber is not particularly noted for giving a uniform sliver in spite of the doubling of several slivers together which occurs on the front table, and so in this respect there need be little or no difference in treatment at the drawing frame, as between a carded and an ordinary combed sliver. Largely for this reason there does not exist much difference in the treatment of carded and combed slivers at the drawframe, there being often the same number of heads of drawing and the same number of ends up for much the same class of Egyptian cotton, whether the cotton be combed or only carded.

The comber, however, does make the fibres parallel, and in this way it diminishes the value and need of the drawframe, and in some few cases combed Egyptian slivers are only passed through three heads of drawframe, whereas the same firm might pass carded Egyptian slivers through four passages of drawframe. This latter practice, however, is optional, and not extensively adopted.

To sum up we may state in a few words that the average drawframe treatment of carded and single combed slivers does not vary much.

Timing and Sequence

Q. 1910. State what is meant by the "timing" of a comber, and describe the arrangement by which it is effected. State each operation of the machine in sequence, during one complete cycle, giving the approximate timings of each.

A. By the "timing" of a comber is meant the order or sequence of the various principal movements as indicated by the index wheel. The index wheel is a large wheel fixed on the gearing end of the cylinder shaft, and usually containing 80 teeth on the Heilman comber. The face rim of this wheel is divided out and marked into 20 parts of four teeth each, which rotate past a pointer or index finger. The index wheel is often of considerable assistance in making the various adjustments. For instance, for Egyptian cotton we may set the feed of cotton to commence at 5 of the index wheel, the top comb to be down at $5\frac{1}{2}$ or two teeth beyond the 5 mark. Then the detaching rollers to commence delivery of cotton at 6, leather roller to touch fluted segment of cylinder at $6\frac{1}{2}$, nippers to shut on the cotton at 9 of the index. If it be a clutch-box comber, the clutch may engage at $\frac{3}{4}$.

The sequential order of the chief operations consists in feeding the cotton, nipping and holding it while the front portions of fibres are combed by cylinder needles, drawing the combed cotton through the needles of the top comb by the detaching rollers, delivery of the cotton, doubling the several slivers on the long front table, and final placing in the sliver cans.

Central Organs of Heilmann Comber.

Fig. 8 is subdivided into four parts each one complete in itself, each one showing all the central organs of the Heilmann comber, the letters referring to the same mechanisms in each case, but each sub-figure indicating a different period of the combing or detaching process.

In each case A represents the cylinder shaft; B, the half-lap or needle segment; C, the fluted detaching part of cylinder; D,D, the short and long steel detaching rollers; E, the leather detaching roller; F,F, the feed-rollers; G, the bottom nipper; H, the top nipper; and T, the top comb.

Fig. 1 indicates the positions of these central organs when cylinder combing is just commencing, the nippers being closed, the top comb lifted, the feed rollers stopped.

Fig. 2 shows little alteration in these parts excepting that the cylinder needles are just finishing.

Fig. 3 shows the commencement of detaching and Fig. 4 the conclusion thereof.

In Figs. 3 and 4 the nippers are shown open, the top comb

down, the cylinder needles out of action, the feed-rollers projecting a fresh portion of cotton forward, the fluted segment on top, and the detaching rollers drawing the combed cotton forward.

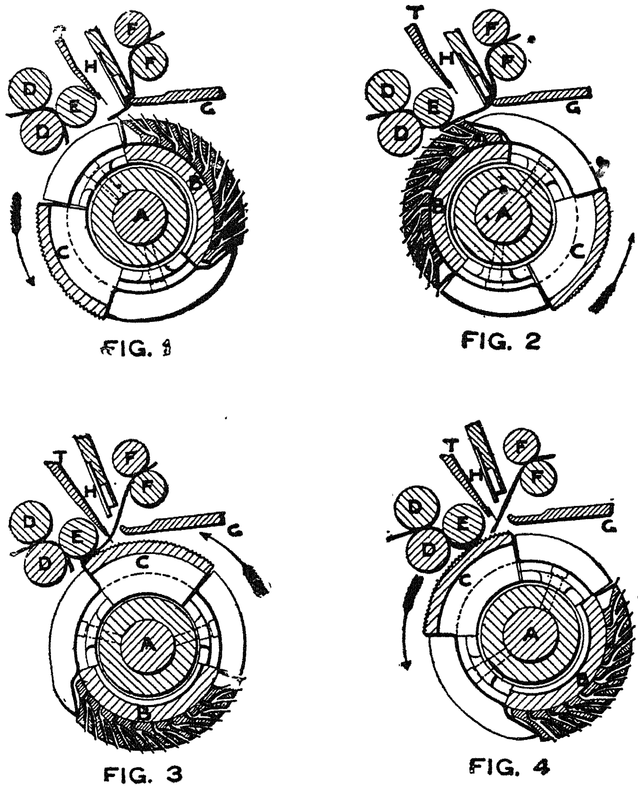


Fig. 8.

The cylinder is built up in a manner which makes it easy to execute repairs. It is built up in segments screwed round the centre. Each row of needles may be removed for repairs. Re-needling of these segments is a special business to be done at the machine shops.

FULL EXPLANATION OF ACTION OF NEEDLE SEGMENT.

Q. 1910. Describe in detail the action of the needle segment of the combing machine on the tuft of lap held by the nippers, and state what proportion of the length of fibre projecting through the nippers is effectively treated by the needles. How many combings by the cylinder needles would you expect an average Egyptian fibre to receive before being detached?

A. Assuming the leading ends of certain fibres to be just projected through the nippers in one certain nip, the next rotation of cylinder needles would only just manage to touch the same, or might entirely fail to do so. The average length of fibre projection is not far removed from $\frac{1}{4}$ inch, so that the next passage of cylinder needles would positively comb the heads of these fibres. The needles would still further penetrate the fibres the next time round, so that the heads of the fibres would probably receive, say, three combings, and the middles of the fibres possibly only one, and certainly no more than two. With anything like close setting it is probable the detaching rollers would draw the tails of the fibres through the top comb before the cylinder needles come round again. The rear portions of the fibres never are combed by the cylinder needles, but depend upon being drawn through the needles of the top comb. Roughly speaking the leading halves of the fibres are combed by the cylinder and rear halves by the top comb.

Q. 1911. State the principles underlying the preparation of laps for combing, and state also the effect which it is desired to produce upon the arrangement of fibres, at this stage. Specify the defects in card slivers which make them unsuitable for combing without preliminary treatment.

A. The chief principles involved in preparing comber laps may be stated as follows: (1) The conversion of a number of slivers into a lap or sheet of cotton, which is in very convenient form for use at the comber. (2) The better equalising of the slivers or laps. (3) The flattening out of each round sliver and equal piecing to or side by side arrangement with other slivers. (4) The arrangement of the fibres in approximately parallel order. The slivers from the card

are not sufficiently uniform for direct feeding to the comber, the sliver is too round and thick for such direct use, the fibres are much too crooked and crossed over each other for adequate treatment by the comber needles, and finally the back of the comber would be fearfully crowded with sliver cans if taken direct from card to comber. The quality and quantity of the work from the comber are much improved by the preliminary straightening of the fibres, the equalising effect of doubling, and the transposing of the cotton from sliver into lap form by the drawframe and sliver lap method, or by the alternative sliver lap and ribbon machine method.

Q. 1911. Specify the distinctive features of the combing machine, in its action upon the material, which are not possessed by any of the other cleaning machines in use for cotton spinning. State fully how these differences affect the ultimate quality of the yarn.

A. The most distinctive feature of the comber is its ability to definitely reject as noil or waste nearly all fibre below a certain standard of length while taking the long fibre forward in the shape of much improved sliver. It also possesses in a more perfect degree than any other machine the ability to extract any fine dirt, nep, or fine impurities of any kind. This latter object is attained by the "tails" of the fibres being drawn through the fine needles of the top comb, after the "heads" of the fibres have been combed by the passage of the cylinder needles. This positive and negative combing effect upon the "heads" and "tails" of the fibres respectively is also responsible for a very parallelising effect upon the fibres. In the respects of extracting short fibre and combing of the fibres the nearest equivalent machine is, of course, the carding machine, but this falls a long way behind the comber when a very decided effect is required. The cotton is intermittently projected forward by the feed mechanism at the rate of about $\frac{1}{4}$ inch per nip, then the nippers close, and the cylinder needles pass through the leading ends of the fibres. Afterwards the nippers open, and the detaching mechanism draws the rear portion of the fibres through the needles of the top comb. The effect of cotton combing is to produce a far stronger and more silky looking yarn for the same counts, while the spinning is usually much better. There are fewer projecting fibres from the surface of the yarn.

Driving and Gearing of Heilman Comber.

Fig. 9 represents a complete gearing plan of a single nip Heilman comber made by Messrs. Dobson and Barlow.

The fast and loose driving pulleys may be 10 inches diameter taking a belt 3 inches wide.

Near the fly wheel—which is convenient for turning the machine by hand—is a 21's pinion driving an 80's wheel on the end of the cylinder shaft.

This 80 drives a second wheel of 80 teeth fixed on the end of the cam shaft, so that the cylinder and cam shafts make equal revolutions.

At the opposite end of the short driving or pulley shaft is a 34 driving a 34 stud wheel; and compounded with the second 34 is a 22 driving a 25 on the shaft of the revolving waste brush cylinder.

Assuming the comber to make 80 nips per minute the brush shaft speed will be as follows:—

$$\frac{80 \times 80 \times 34 \times 22}{21 \times 34 \times 25} = 268 \cdot 1$$

It is thus seen that the waste cylinder revolves very quickly. By contrast the feed rollers revolve very slowly.

An adjustable stud or feed peg on the cylinder near the 80's wheel drives a star wheel of 5 teeth or notches 1 revolution for every 5 of the cylinder. A feed change wheel of from 13 to 20 teeth or so is compounded with the star wheel, and drives a feed roller wheel of 38 teeth. Taking the change wheel at 19 teeth we get revolutions as follows:—

$$\frac{80 \times 1 \times 19}{5 \times 38} = 8$$

On the other end of the steel feed-roller is a 22's bevel wheel driving a 21 on side shaft. On other end of side shaft is a 20's bevel driving a 55 compounded with a 36 spur wheel, which drives the 49's on wood lap rollers as shown in Fig. 9.

On the cam shaft is a double worm which drives a 14's worm wheel on bottom of upright shaft, and on top of this upright is a 20's bevel driving a 20's on the shaft which drives the table calender rollers.

On the coiler end of the cylinder shaft is a 25's bevel wheel which drives a 25 on either side—one for the doffer drive, and

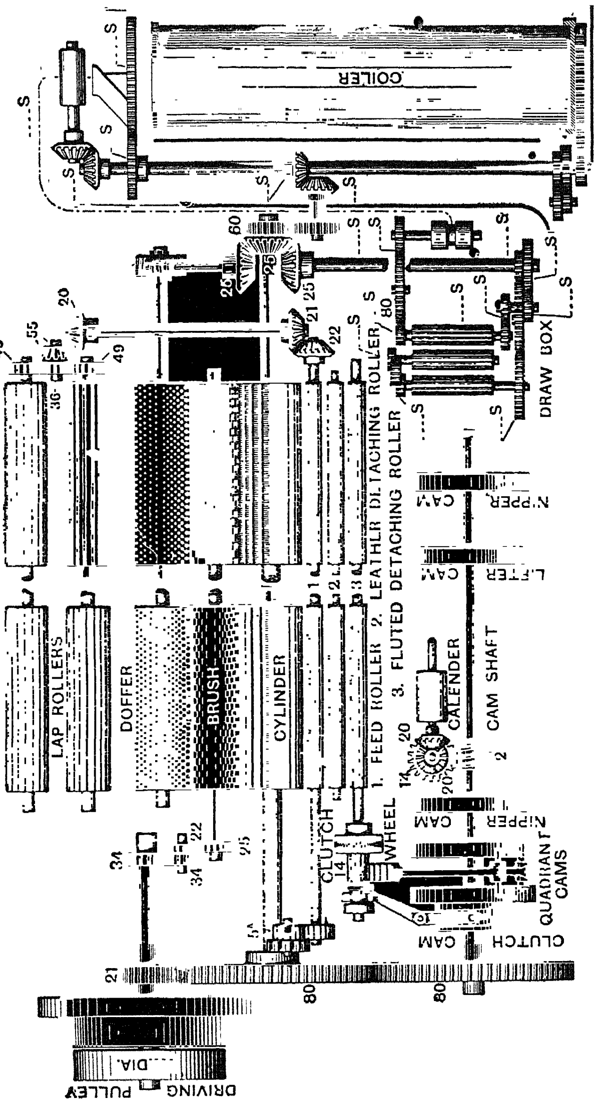

COILER
DRAW BOX
LAP ROLLERS
DOFFER
BRUSH
CYLINDER
1. FEED ROLLER 2. LEATHER DETACHING ROLLER
3. FLUTED DETACHING ROLLER
CALENDER
CAM SHAFT
NIPPER CAM
LIFTER CAM
CLUTCH
WHEEL
QUADRANT CAMS
CLUTCH CAM
DRIVING PULLEY
DIA.

FIG. 9.

the other for the drawbox driving. For the doffer a single worm drives a 32's worm wheel fixed on doffer, so the doffer revolutions are few.

$$\frac{\overset{\text{Cyl. revols.}}{80} \times 25 \times 1}{25 \times 32} = 2 \cdot 5 \text{ revols. per min. for doffer.}$$

The table and block calender rollers may be taken at $2\frac{3}{4}$ inch diameter and the same with the fluted wood lap rollers.

Dimensions of wheels for the drawbox in one case are given as follows:—

Wheel on front cross shaft 14, driving through a carrier a 50 on back roller in drawbox. Diameter of drawbox bottom rollers $1\frac{3}{8}$ inch. Front cross shaft wheel 50, driving a 45 stud carrier wheel with which is compounded a 40 driving a 34 on front roller of drawbox.

A 31 on back roller drives through a carrier a 25 on middle roller in drawbox. A 22 on front roller drives through a carrier, a 40 on the drawbox calender.

A 60 spur wheel on cylinder drives a 59 on short shaft, and on other end are 22's mitre bevels for driving the upright shaft in coiler box.

The wheels at can bottom may be taken as follows:—

$$\frac{13 \times 13 \times 13}{36 \times 36 \times 84}$$

Q. 1913. Fully describe the differences in strength, appearance, construction, and general characteristics between combed and uncombed yarn from similar cotton. State how these differences are produced by the combing machine, indicating which sections of the machine are responsible for each of them.

A. A yarn produced from combed cotton is stronger, cleaner, and more silky-looking than a yarn of similar counts produced from the same kind of cotton which is not combed. The fibres are rather more parallel in the combed slivers owing to being drawn through the needles of the top comb, and to the passage of the cylinder needles through the cotton. The needles of the top comb resist the passage of short or crossed fibres and any small particle of nep, dirt, or other undesirable material, with the result that the cylinder needles take these

round to the waste brush during the next revolution. Because the combed yarn is cleaner, has fewer short fibres to detract from its strength, and has its fibres if anything more parallel, it follows that it is stronger and better looking than the non-combed yarn. Short fibre never reaches from the nippers to the detaching roller, and so is not drawn forward with the long fibre by the detachers, but is left behind the top comb. The needles of the cylinder and top comb are too closely set to permit impurities to pass along with a good sliver. The cylindrical waste brush cleans the waste from the cylinder, the doffer cleans the revolving brush, and the doffer comb cleans the waste from the doffer.

Q. 1914. Describe how the "overlap" of the piecing is formed by a combing machine. State the approximate length of the overlap formed by the Heilman and Nasmith combers respectively.

A. The method of obtaining the piecing or overlap of the cotton—an operation which takes place 80 to 90 times per minute—is much the same in principle on both the Heilman and Nasmith combers. After combing by the cylinders has occurred, a portion of the previously combed cotton is returned from the collecting tin by the detaching rollers, and the end of this combed cotton passes down the bottom detacher, between it and the cylinder. Almost simultaneously the portion of cotton just operated upon by the cylinder needles, *i.e.*, the leading end or fringe of the lap sheet, is brought forward by the detaching mechanism and laid upon the returned end of sliver brought back from the front tin. The actions of the central organs are timed so that the pieced up cotton is beginning to deliver in unison with the making of the piecing. The overlap is very much longer with the Nasmith than with the Heilman comber, and may be something like $\frac{5}{8}$ inch in the Heilman and three times as much for the Nasmith. In the Heilman the overlap is much shorter than the fibre length, while in the Nasmith it may easily exceed the length of even good cotton fibre.

The Roth Aspirator.

At the time of writing this note—the beginning of 1915—the Roth aspirator has been applied to a very limited number of combers in this country, two or three of our machine

makers having obtained licence to apply it from the French inventor.

Among practical men opinions are divided as to its merits and demerits.

The aspirator may be applied either to the Heilman or the Nasmith comber.

This aspirator, working in conjunction with the brush, replaces the doffers and doffing combs by a perforated tube and damper, acting on the same principle as the scutcher cage. A small fan placed under the headstock, driving from the driving shaft, provides the draught, which is only slight.

The advantage of this apparatus is that it not only collects the waste from the brush, but also all the fly from other parts of the comber, and keeps the room clean. So much is this the case that it is never necessary to stop for cleaning except at the week-end to clean the machinery parts. The production of the machine is increased by saving cleaning time, and one tenter can take care of an extra machine.

Fig. 10 shows the aspirator as perfected and applied by Messrs. Dobson & Barlow, the illustration being self-explanatory after reading the foregoing.

Q. 1914. Describe the method of construction of the comb cylinder of a combing machine, giving full details of the manner in which the various rows of needles are arranged and set for (*a*) opening out and straightening the lap fringe, and (*b*) retaining and carrying forward the short fibre.

A. In the Heilman comber the cylinder is made to assist very materially in the detaching of the cotton as well as in the actual combing of the cotton fibres. As regards the needle segment or half lap, there is little difference in construction so long as the same approximate weight and thickness of lap sheet is to be operated upon. There are usually seventeen rows of needles (in the little used duplex comber thirteen rows) in each needle segment, and the needles are graduated in thickness of needle and close setting of needles, on the same principle as in using large toothed and then a small toothed comb. The first rows of needles to pass through the cotton are comparatively thick, and may be set at the rate of about 30 per lineal inch, whereas the last rows of needles to pass through the cotton are much thinner, and reach to as many as possibly 88 per lineal inch for some sorts of work.

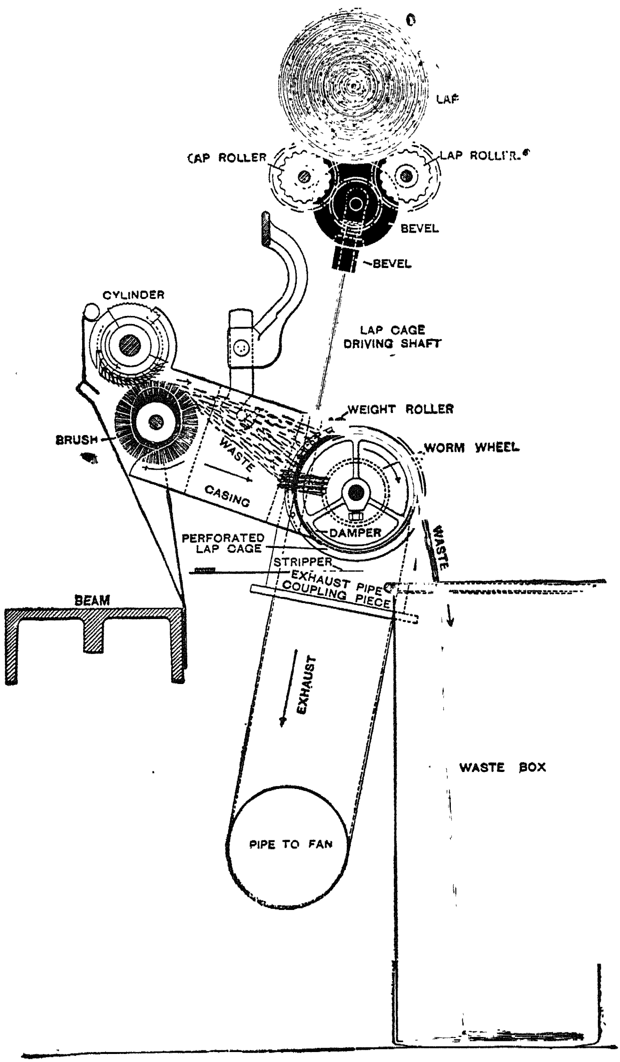

LAP
LAP ROLLER
LAP ROLLER
BEVEL
BEVEL
CYLINDER
LAP CAGE
DRIVING SHAFT
WEIGHT ROLLER
BRUSH
WASTE
WORM WHEEL
CASING
DAMPER
PERFORATED
LAP CAGE
WASTE
STRIPPER
EXHAUST PIPE
COUPLING PIECE
BEAM
EXHAUST
WASTE BOX
PIPE TO FAN

Fig. 10.

Between these commencing and finishing rows of needles there are rows of varying thicknesses and settings of the needles graduated between the two extremes we have specified.

In regard to the carrying capacity of the needles so as to have them take out the short fibre and fine impurities, a sufficient hook or angle is given to the needles in the direction of rotation, thus enabling them to hold sufficiently without hindering the cleaning effect of the doffer brush which sweeps the waste off the cylinder. In one case the thicknesses of the round steel teeth are given as follows: Four rows of 20's, three rows of 22's, two rows of 24's, two rows of 26's, two rows of 28's, two rows of 30's, two rows of 33's. These steel needles are very sharply pointed to give the greatest combing efficiency.

Birch's patent for the Heilman detaching leather roller enables the weights to be brought much nearer to the leathers, thus reducing the possibility of spring or unlevel action in the roller.

The Nasmith Comber.

Central Organs of Nasmith Comber.

During the period from 1903 to 1915 the Nasmith comber has come very largely into favour.

The action of those central parts which are directly concerned in feeding, nipping, combing and detaching the cotton, may be described as below, in connection with the three parts of Fig. 11. Fig. 11, A, B, C shows the main organs in three positions. The first, Fig. A, shows the needles passing through the end of the lap, held down by the closed nipper, which is now in its rearward position (the dead point of the crank). Before the fine needles have passed, the nipper is already moving forward in the same direction as the cylinder, thus reducing the effective speed at which the needles are passing through the cotton and easing the strain on the fibre. In Fig. B of Fig. 11 the needles have passed and the nipper is about the middle of its path toward the detaching rollers. As the last row of needles passes under the detaching rollers, the latter turn backward, and, owing to the top roller leaning toward the cylinder, the end of the combed fleece thus delivered backward is projected

into the space between the last row of needles and the plain segment whose front edge strokes the fleece close against and under the bottom roller, so as to present a clean surface to the advancing nipper tuft for piecing. Meantime the nipper having opened, the lap end rises automatically and points directly towards the nip of the rollers. It would rise higher, but is met by the falling top comb and kept in proper position. The detaching rollers now begin to turn forward and seize the tips of the

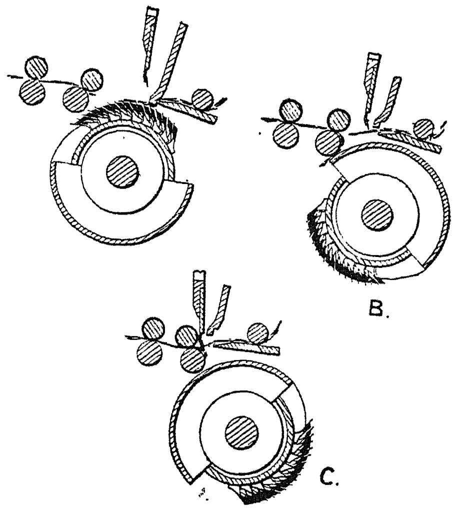


FIG. 11.—Improved detaching and overlap.

fibres presented by the advancing nipper and pull the lap end into the top comb. The nipper continues to advance, but with diminishing speed (approaching the dead point of the crank), thrusting the end of the lap gradually into the nip of the rollers, which successively seize fresh fibres and draw them off through the top comb. The top roller moves away before the advancing nipper and top comb, but is eventually overtaken by them as both the nipper and roller arrive at the end of their respective paths; this is best seen in Figs. B and C. The rollers continue their rotary movement an instant longer to commence the

separation, which is completed by the withdrawal of the nipper and top comb, leaving a short combed end projecting from the rollers, and the process recommences.

The overlap of the piecing thus obtained is about 2 inches as compared with about $\frac{5}{8}$ of an inch on a Heilman for any staple. Further, the detachment is a comparatively slow and continuous operation, compared with a practically instantaneous snatch in the Heilman, as both leather roller and fluted segment are moving at full speed when they fall together, whereas the rollers in the Nasmith are only starting up slowly when they seize the nipper tuft. Again, the Heilman roller drops on the

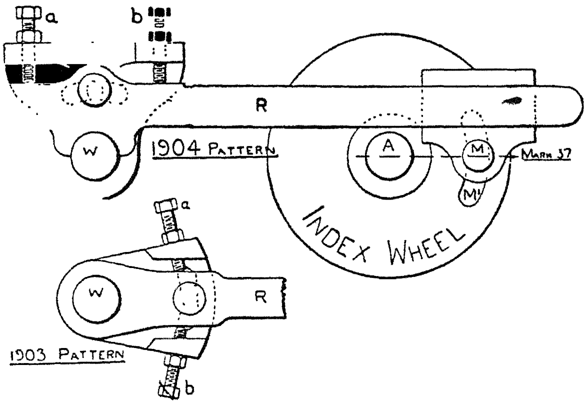


Fig. 12.

nipper tuft about $\frac{3}{8}$ to $\frac{1}{2}$ inch from the tip, and, so to speak, in the quick of the lap, where it draws with difficulty, whereas the Nasmith rollers seize the lap by the extreme tip, where it draws easily and without undue strain. The Heilman rollers have to complete the separation without assistance from the nipper, consequently some of their forward movement is unproductive, while the forward motion in the Nasmith is almost entirely used for producing, the separation being completed by the retirement of the nipper.

The Crank Motion and Nipping Mechanism.

A good deal depends upon the action of the crank motion in the Nasmith comber as shown in Fig. 12.

This Fig. 12 shows the crank M on the end of the cylinder shaft A for rocking the nipper shaft W. The peculiarity of this motion is the slow advance of the nipper towards the detaching rollers, allowing maximum time for the detaching operation and the quick return. The motion of the nipper is continuous, smooth and quiet.

Figs. 13 and 14 are sections showing the parts at the close of the detaching period and during combing respectively. Figs. A, B, and C of Fig. 11 show the position of the parts at various points of the stroke.

The combing cylinder has seventeen rows of needles, no fluted segment to wear the brushes, plain ends without bosses or set screws, and is completely enclosed.

The nipper, driven by a crank, is silent and self-contained with fixed lower jaw that cannot touch the cylinder. It has no leather covering, closes gently without hammering, with little tension on the springs when opening, the weight coming on gradually as it closes. It swings on 1 inch studs 3 inches long, rocking in cast-iron bushes, and never requires re-setting.

The nipper shaft W, Figs. 12, 13 and 14, is rocked to and fro by a crank, Fig. 12, and is connected to the nipper bridge S by the arms W^1 and connecting rods V (two to each nipper), with adjusting nuts V^1, so that the nipper jaws may be set parallel to and at the proper distance from the steel detaching roller D. Once all the nippers are correctly set, their distance from the roller D may be altered simultaneously by the screws a and b, Fig. 12. The nipper bridge S is bolted at each end to an upright N secured to a stud N^1, which rocks in a bush carried in the framing. The top nipper arms pivot on studs P^1 carried in projections cast on the bridge S. At the lower end of the arm a cross bar carries a bowl N^5, which comes in contact with the adjustable incline J and opens the nipper as it moves forward. When the nipper moves back for combing, Fig. 14, this bowl leaves the incline J, and the nipper closes under the influence of springs attached to the lower end of the nipper arms. There is little pressure on the springs when the nipper is opening, but a

strong pressure when closed during combing. The opening and closing thus takes place gently and without the detrimental hammering blow observable in the Heilman and

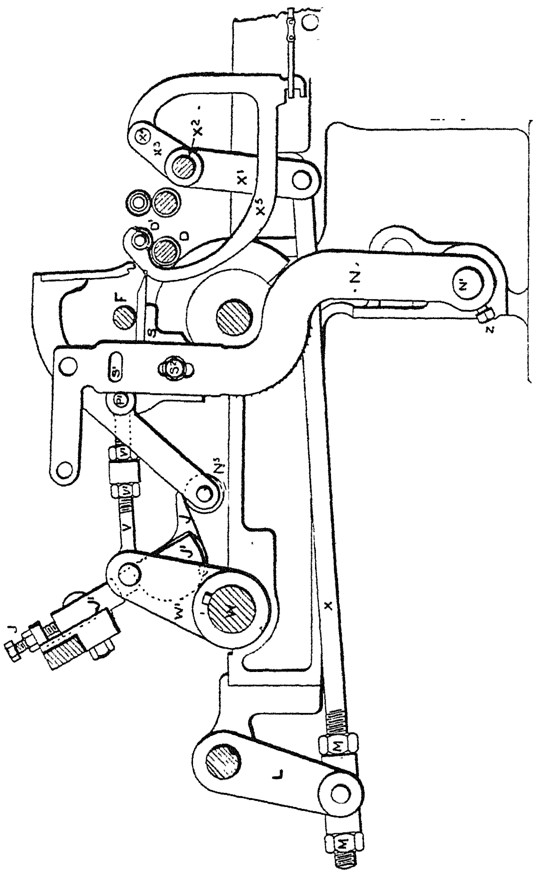


FIG. 13.

other combers. The nipper is adjustable to the needles by set screws T, Fig. 14, and once set is a fixture and cannot be made to touch the cylinder, as its path if continued in both directions never intersects the circumference of the cylinder.

The Feed Roller.—Each nipper carries its own feed roller F, Figs. 13 and 14, which is adjustable on the nipper plate, so that its distance from the jaw of the nipper is easily set to suit the length of the fibre operated on. The roller receives its rota-

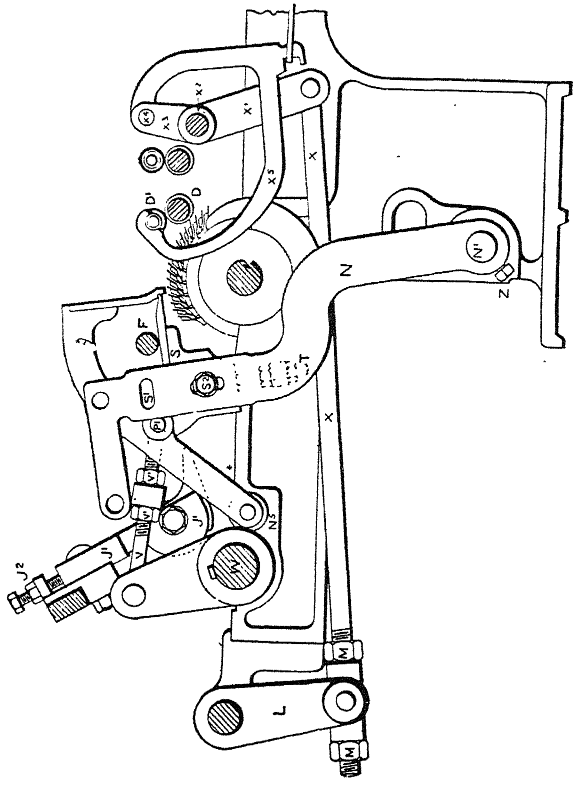


FIG. 14.

tion from the movement of the nipper through a ratchet and pawl. The roller turns inside a stationary bush, and the ratchet lever rocks on the outside of the bush, so there is no contact between the roller and ratchet except through the pawl, the whole being enclosed in a casing to exclude fluff and dust. There are no change wheels, the amount of feed being altered by the simple displacement of a stud.

The Top Comb.—Fig. 15 shows the disposition of the top comb C, which is bolted to the slot in the arms C^1. This slot and set screws C^5 permit an adjustment of the angle of the comb within the required limits. The arms C^1 are pivoted on the nipper frame at C^3, and consequently participate exactly in the reciprocating motion of the nipper. During combing the weight of the comb rests on the set screws C^4, which re-

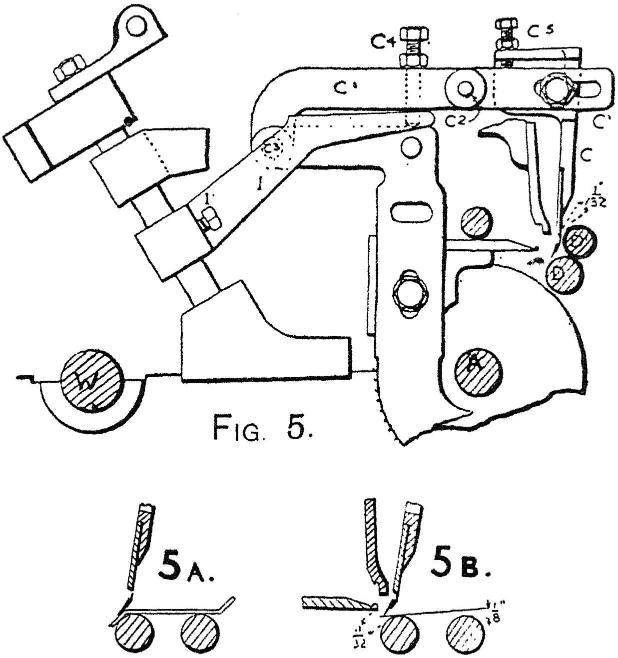


FIG. 15.

gulate the depth of penetration of the comb. When the nipper goes back the bowl C^2 comes in contact with the adjustable bar I and is gradually raised to keep the comb clean. Thus the height at which the bar I is adjusted determines the moment or time when the top comb enters the fleece and the set screws C^4 the depth of penetration.

It will be noticed from the foregoing that the opening and

closing of the nipper, the raising and lowering of the top comb, and the rotation of the feed roller all result naturally from the reciprocating motion of the nipper driven by a simple crank. The small sketches below Fig. 15 show the use of the trowel gauge in setting the top comb.

The Detaching Rollers.—The position and action of the steel detaching roller D, Figs. 13 and 14, is identical with that of the Heilman machine, except that the rotation of the roller continues a much greater time during each stroke in the Nasmith than in the Heilman. The surface speed of the roller never exceeds that of the Heilman roller, it only takes a longer time to perform its greater arc of revolution. Again, the surface speed of the Heilman roller must coincide exactly with that of the fluted cylinder, and after backing-off it must acquire this speed in the briefest possible fraction of a stroke. The leather roller never coming into contact with the cylinder, no such embarrassing restriction exists in the Nasmith machine, and the rollers stop and start gently, the cam being designed to start and stop the sector just as a crank would.

The Leather Covered Detaching Roller.—D^1, Figs. 13 and 14, never comes in contact with the cylinder, but rests simply on the bottom roller, from which it receives its rotary motion, and in addition to this it receives a bodily movement to and fro, from the position of Fig. 13 to that of Fig. 14. This is obtained from the lever L keyed on its shaft, and operated by a simple eccentric on the cylinder shaft (not shown). The connection is made through the rod X with adjusting screws M M to the lever X^1 and the weight hook X^5.

Five important advantages result from this disposition :—

1. The time available for detaching and drawing through the top comb is greatly prolonged.

2. The top roller is as easily set as a drawing head roller, doing away with any delicate adjustment.

3. No definite and fixed surface speed of the roller is imposed, and a smooth cam takes the place of the abrupt notch wheel cam.

4. The shock and deflection of the leather roller dropping on the cylinder under the influence of weights is done away with, and a 25-pound weight works a 10½-inch lap of 600 or 700 grains per yard.

5. A long overlap and perfect piecing are obtained even with cotton fibre of only one inch length.

Various Particulars of Nasmith Comber.

The high production of the Nasmith comber makes it convenient for double combing either with one Heilman and one Nasmith, or both Nasmith combers.

The second combing with a Nasmith may extract as low as 3 to 8 per cent.

Speeds suggested by the makers are as below with comber pulleys 10 inches diameter by 3 inches wide.

For finest Sea Islands cotton .	335 revols.	=	86 nips.
,, Florida Sea Islands cotton	350 ,,	=	90 ,,
,, Egyptian and best American cotton . . .	370 ,,	=	95 ,,
,, Coarse work . . .	390 ,,	=	100 ,,

The Nasmith comber is claimed to be capable of dealing with all lengths of cotton fibre from $\frac{7}{8}$ inch to 2 inches.

It makes a good piecing with long overlap even on the shortest cotton.

The quantity of waste is easily controlled, and if desired it will work with very low waste, even on short staple, for semi-combed yarns.

All its motions, except those of the detaching rollers, are continuous, so that there is only one cam in the machine, which runs very quietly and with proportionately reduced wear and tear.

Its mechanism and adjustment are very simple, it rarely requires resetting, and all its parts are easily accessible.

There is no leather covering required on the nipper which, once set, cannot be made to touch the cylinder.

It occupies the same space as a Heilman comber of the same number of heads and width of lap, but stands 4 inches lower for convenience of the tenter. The headstock is cast in a solid piece.

The bearings of the cylinder, nipper shafts and detaching rollers are split bushes of standard size, easily and cheaply renewable when necessary.

The nipper pivots are plain studs in cast-iron bushes, therefore renewable at a trifling cost.

Weight of laps $10\frac{1}{2}$ inches wide. (Narrower laps proportionately lighter.)

For superfine Sea Island .	12 to 18 dwt.	per	yard.
For Florida cottons . .	18 to 22	,,	,,
For Egyptian and American cottons . . .	22 to 32	,,	,,

Preparation of Laps.—Heavy laps are more liable to vary than light ones, unless care is taken in roller setting in the lap machines. A sliver lap machine is recommended to follow the card with a ribbon lap machine to make laps for the comber. The latter is found to be a very satisfactory machine for heavy laps, as an end is rarely down, and there is consequently little waste and few bad places in the laps.

The production naturally varies as in other combers, according to the quality of work required, and depends largely on the nature of the cotton. At 100 beats per minute, with 25 dwt. laps, and allowing 15 per cent. for waste, a six-headed machine easily produces 800 lb. in 50 hours. Generally if the weight in grains of a yard of lap, after deducting the waste, be divided by 18·7 it will give the pounds produced per head per hour.

The waste for ordinary work may vary from 12 to 30 per cent., and for semi-combed 5 to 12 per cent., according to the quality required.

The quantity is under complete and easy control, and may be altered to any extent in a few minutes. The chief factor in determining the length and consequently the amount of waste is the distance between the nipper and the steel detaching roller when the nipper is at the forward end of its path.

The brush and doffer shafts can be lifted straight out behind without disturbing anything else.

The front plate extends backward to the detaching rollers, completely covering the calender shaft.

A convenient weight-relieving motion obviates the lifting of the detaching roller weights by hand.

A selvedge guide between the detaching rollers ensures perfect selvedges instead of trailing, ragged ones.

The drawing head is made with four rows of rollers.

To change from long to short cotton takes less than an hour.

When requested, full can stop motion, front stop motion, and coiler stop motion are applied.

The Roth aspirator can be applied to the Nasmith comber if desired.

NOTE.

Among the latest Nasmith improvements are the following:—

(1) Arrangement to keep the moving nipper concentric with cylinder.

(2) Making the piecing between the two pairs of detachers.

The Whitin Comber.

This comber was introduced into this country a few years ago by Messrs. Howard & Bullough. The name Whitin is obtained from the machine making firm in America identified with its original construction in 1905, the chief inventor being Mr. Rooney. The author of this treatise very fully examined the earliest machine put together in England and noted its chief differences from the Heilman comber.

First and last the Whitin comber is built upon the lines of the Heilman, with important differences in detail, but much more adhering to the Heilman constructional design and detail than is the case with the Nasmith. Both the Whitin and the Nasmith maintain Heilman's fundamental principles of first combing the heads of the cotton fibres by means of revolving cylinder combs, and then combing the tails of the fibres by using detaching rollers to draw the fibres through the needles of a top comb.

As examined by the writer, the Whitin high-speed comber contains 8 heads, takes laps 12 inches wide, occupies the same space as a Heilman taking $10\frac{1}{2}$ inch laps, and is claimed to run at a normal speed of 130 to 135 nips or quite as quick as the duplex Heilman comber. The thickness of lap is kept much the same as for the ordinary Heilman, and extra production obtained by using a high speed and a wide lap.

The Cam Shaft.—This is made on the Duplex system of having a double acting cam for the top nipper, and duplicate, notch-wheels and frog cams for revolving the detaching rollers.

The cam shaft, however, only makes one revolution for the cylinder two revolutions.

Feeding, nipping, combing and detaching are kept much the same as in the ordinary single nip Heilman comber, but

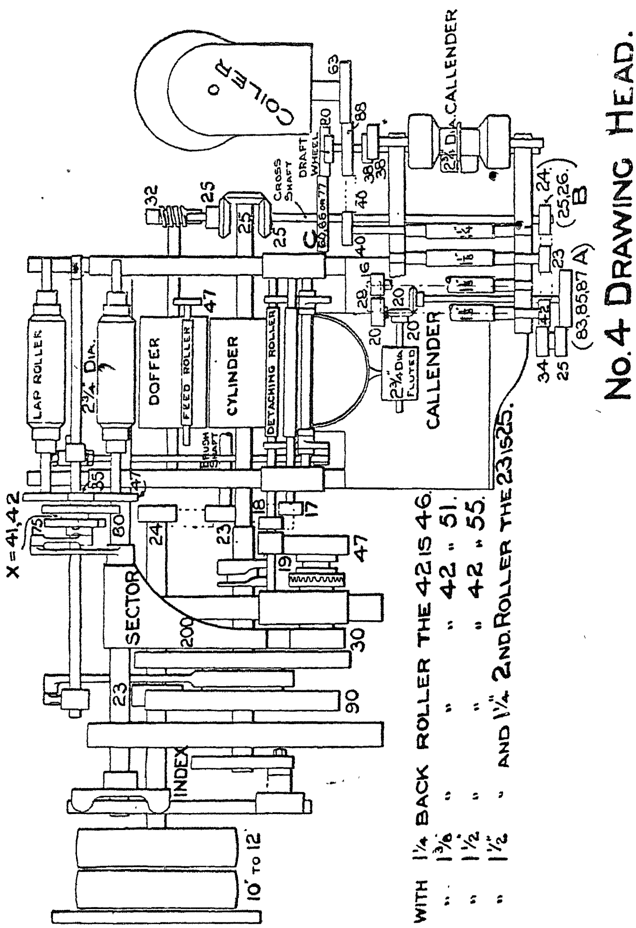


FIG. 16.—Gearing Plan of Nasmith Comber.

there are variations in the actuating mechanism which permit the use of high speeds, and the machine has experimentally

been run for a short time at 200 nips per minute as a test for vibration. Shaking and vibration are overcome by such devices as the following:—

(1) By eliminating the rocking motion of the cushion plate and fixing this in combing position, whereas in the ordinary Heilman the cushion plate or bottom nipper has a swinging movement of approximately $\frac{1}{4}$ inch to $\frac{3}{8}$ inch.

This fixed position reduces the amount of throw required for opening the nipper jaws, and also allows the position of the feed rollers to be dropped, which permits the combing of shorter stapled cotton by bringing the bite of the feed rollers closer to the nippers.

(2) The lifting mechanism of the top detaching rollers, consisting of the usual cams and levers, is eliminated, the top roller being raised and lowered for piecing by a bevel on the cylinder segment, which is a positive action and does not wear the leather.

(3) A tension device is applied to the brass top detaching roller to prevent skipping its flute, after the style adopted on some duplex Heilman combers.

(4) There are duplicate cams and notch wheels for the rotating of the detaching rollers, and double acting cams for the nippers.

(5) Other details may be specified as follows:—

Twenty rows of cylinder needles as against the standard 17 rows in the Heilman, although in Anderton & Dobson's patent there are 22 rows in the Heilman.

No movement whatever for the top comb. Electric stop motions to cover every position where a breakage of sliver is likely to occur.

A tell-tale signal, or upright shaft indicator which informs anyone concerned whenever a comber is stopped, this being applicable to other machines if required.

A waste packer consisting of a tin plate secured between the arms of the doffer, and used to automatically press the waste down into the rectangular boxes so as to make them hold double quantity.

Weight relieving motions for leather detaching and for drawbox rollers.

Bosses of leather rollers lengthened to take 12-inch laps without increasing total length of rollers.

The Whitin comber is really an inproved single nip

Heilman having only one segment and one half-lap on the cylinder.

Writing in February, 1915, it may be said the great success of the Nasmith comber has apparently seriously affected the progress of all other makes of cotton comber, such as the ordinary Heilman, the Whitin, the Willis and Jolly comber, the Alsatian and the Delette, the last two not being used at all in England at the time of writing. The greater perfection of the cylinder combing of the Heilman, however, helps it to keep in favour for high-class combing, the nippers being stationary all the time the cylinder needles are acting. Many comber men consider the Heilman better than any other in this respect.

CHAPTER II.

THE DRAWING FRAME.

Q. 1898. Why are slivers drawn? What faults are corrected, and how? Give full reasons for your answer.

A. There are two principal reasons why slivers are drawn—first, to make the slivers more uniform, and, secondly, to make the fibres more parallel. Slivers from the card or from the comber are usually by no means sufficiently uniform in weight and thickness for any given short length. By doubling six or eight slivers together at the back of the drawing frame, and reducing them to practically the dimensions of one by the drawing rollers, it is found that these inequalities are very greatly reduced, and especially when the doubling and drawing have been performed at all of the three heads of drawing usually employed.

It is also an important practical virtue of the drawing rollers that they operate on the fibres so as to reduce them to an approximately parallel order to each other. This latter benefit is obtained by each successive pair of rollers the cotton comes to being made to revolve more quickly than the preceding pair, so that the front end of the fibres are being constantly drawn forward more quickly than the rear ends.

The best practical reasons that can be given for these remarks are furnished by an actual examination and comparison of the slivers and fibres from the card and from the last head of drawing, when the merest tyro can see that both benefits are attained.

Q. 1900. State fully what is the principle of drawing cotton fibres. What are the chief objects aimed at, and what occurs to the fibres at different points in their passage? Do not give in your answer any

further description than is necessary to make the nature of the operation clear.

A. On a drawframe the two principal objects to be attained by the action of the drawing rollers and related mechanism are the more perfect parallelism of the fibres and the greater uniformity in the strand of cotton. While these same objects are also more or less sought in the subsequent processes, they are subordinated to the greatest principle of drawing rollers, *viz.*, the attenuation or thinning out of the cotton without destroying its uniformity.

The principle on which drawing rollers act is to have each succeeding pair of rollers that the cotton comes to revolving more quickly than the preceding pair, so that the foremost fibres are always pulled forward more rapidly than the later ones. Moreover, there is always a momentary tendency for the front ends of the same fibres to be pulled forward more rapidly than their rear ends, which unavoidably causes the

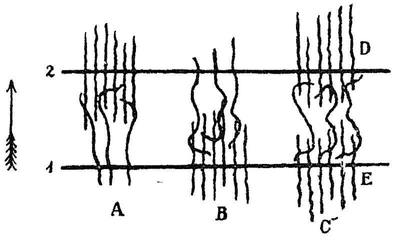


FIG. 17.

fibres to straighten out. With one or two notable exceptions it is the practice to have the rollers set sufficiently far apart to prevent two pairs of rollers having hold of the same fibres simultaneously. As stated, in their passage through the rollers, the fibres are straightened out and separated, and to a very small degree they are cleaned by the liberated impurities, still present to a small extent, falling out.

Referring to Fig. 17, suppose 1 and 2 are two lines of drawing rollers and the fibres at A, B, C are passing through the rollers in the direction shown.

The fibres at A will have their crooked front extremities pulled straight by the quicker speed of the fibres passing through the second line of rollers.

In the same way the crooked rear ends of the front fibres at B in trying to forward faster than the fibres held by the first line of rollers will be pulled straight. If it were possible to have fibres as shown at C between the two lines of rollers they would also be subject to a straightening action due to the front fibres, D, moving more quickly than the back fibres, E.

Q. 1898. Describe generally the construction of a drawing frame, omitting the coiler. How are the rollers constructed? How do you set them? Illustrate by a simple sketch of the rollers.

A. The slivers are drawn from the back cans, and each one passed through an aperture in a guide plate of sufficient size to allow of the sliver easily passing through in a straight condition, but not lumps or knots of sliver. Each sliver then passes over a spoon lever, which is part of the stop motion for automatically stopping the frame when an end breaks or fails at the back. The sliver next passes through a pair of rollers termed the single preventor rollers, and then all the slivers pass through the drawing rollers, which may be termed the principal operating part of the machine, the others being more or less subsidiary to the action of the rollers.

There are usually four pairs of drawing rollers on a drawing frame, the bottom rollers being fluted and acting as drivers by frictional contact with the top rollers. The latter are covered with flannel and then with leather, in order to give a firm, yet somewhat elastic grip of the cotton fibres. Sometimes they are "fast rollers," *i.e.*, the whole of the roller revolves as if it were one solid piece, which it practically is as a matter of fact. A modification of these fast rollers consists in having the ends revolving inside loose bushes, which keep them clean and well oiled. Another form of roller, which is probably more employed on the drawing frame, is the "loose boss," in which the spindle or "mandril" remains stationary, while the leather-covered "shell" or "boss" only revolves.

Taking an Egyptian cotton of average quality, we might have $1\frac{1}{2}$ inches from centre to centre of front and second rollers, $1\frac{5}{8}$ inches between second and third rollers, and $1\frac{3}{4}$ inches between third and fourth pairs of rollers. In determining these settings certain special gauges may be inserted

between the leathers or flutes of the rollers, or between the end bearings and adjustments made accordingly. It must, however, always be understood that these diameters and distances are subject to variations, and in Fig. 18 the particulars are somewhat different from those above given.

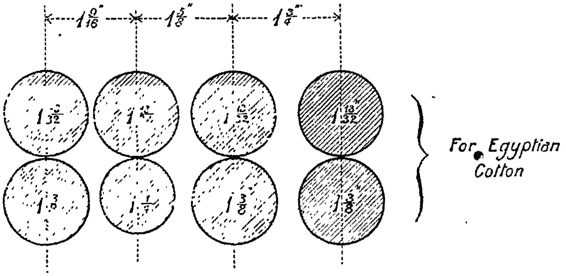


Fig. 18.

Fig. 18 is a sketch of the rollers and is self-explanatory after the above remarks.

Drawframes.

Q. 1896. What advantage is obtained by doubling in a scutching machine, a drawing frame or a spinning frame?

A. The great advantage obtained from doubling at the scutcher is to obtain an even lap. The great advantage of doubling at the drawframe is to produce an even or uniform sliver, and doubling at the spinning machine gives an even yarn. At the scutcher also it is now the common practice to have a pedal or piano feed regulator, which greatly assists in the work of making a lap of uniform thickness and weight. It may also be added that by repeated doubling at the drawframe we are enabled to have repeated drawings of the sliver, and in this way the parallelism of the fibres is secured.

Q. How many drawing processes ought the sliver to receive in medium numbers before twist is put in?

A. It is customary to pass the same cotton through three different drawframes or sets of rollers before taking it to the

slubbing frame. It is at the latter machine that twist is first definitely introduced, so that the answer to the question really is: four processes of drawing for the slivers in carded yarns, and including the draft rollers at slubber.

It may be noted that a slight amount of twist—say about $\frac{1}{20}$th part of a turn per inch—is incidentally imparted to the sliver by the coiler motion of each drawframe, card or comber.

For low counts often only two heads of drawing are used, while occasionally for fine counts four passages are utilised for the same cotton.

Q. 1899. How are the rollers of a drawframe as ready for work constructed (*a*) as to the bottom rollers, (*b*) as to the top rollers? What are the chief faults to guard against in each, and what effect does a rough surface have?

A. The bottom rollers should be made of a good quality of fine grained iron and, according to order, are case-hardened all over or only in the necks. Each roller in its length consists alternately of raised, finely fluted working surfaces, and of smoothly turned necks or bearing surfaces. In most drawframes these rollers extend the length of the frame in practically one piece, but in some, shorter lengths may be coupled together by socket and spigot joints that can be readily uncoupled. The top rollers are made in short lengths of smoothly turned iron, usually covered on the working surfaces with a good level cloth, and then with a special leather, usually prepared from sheepskins. The top rollers rest upon the bottom ones, and contact is firmly maintained by heavy weights hanging from the leather rollers. This ensures a firm grip upon the fibres. Faults possible in the rollers that should be guarded against are bad setting of the rollers, roughening their surfaces in any way, neglecting oiling and cleaning, spoiling the leathers, and working them after being spoiled, having the weights not on the rollers properly, and badly arranged drafts in the rollers.

A rough surface on either top or bottom rollers would cause continual trouble, loss of time, and waste by always sticking to the fibres.

The method of having loose ends to the top rollers of drawframes instead of loose boss rollers appears to be gaining favour.

Q. A drawing frame has four lines of rollers as follows;

front roller, $1\frac{3}{8}$ inches diameter; 2nd line, $1\frac{1}{4}$ inches diameter; 3rd and 4th lines, $1\frac{3}{8}$ inches diameter. Could you draw Indian cotton with these properly and how would you set them? If not, why not?

A. Each of these four rollers is $\frac{1}{4}$ inch too large in diameter for Indian cotton to be worked on them with the best results. It would, however, be quite possible to work Indian cotton of fair length with such rollers, providing they were set as close together as possible without touching. As a matter of fact a vast deal of short staple American cotton has been successfully worked on such rollers to the writer's positive knowledge; this cotton being no longer than Indian of fairly good quality. Unless, however, the speeds and drafts were kept within very reasonable limits, besides the rollers being set as close as possible, we might expect a good deal of waste and many roller laps, because the distance from centre to centre of each line of rollers is really too great for the best results.

Q. 1897. Describe the various methods of weighting drawing rollers. Say which are most commonly employed, and under what circumstances respectively.

A. There are two great styles of weighting drawing rollers in use in connection with cotton spinning machinery, *viz.*, dead weighting and lever weighting. Taking the drawframe first, the predominating system is the dead weighting. There are, however, some advocates of lever weighting, the great argument in their favour being that the weight can easily be varied if required by change of cotton or hank sliver, etc. Most people prefer dead weights, because they are far less liable to get disturbed. On the bobbin and fly frames the system very generally practised is that of dead weighting for all numbers. For the finer cottons it is often the case that the back lines of rollers are self-weighted, *i.e.*, they are made of larger diameter, and exercise sufficient pressure upon the cotton without anything being added to them in any way. As regards the mules, by far the more common method for medium and lower numbers is to have all three lines of rollers saddled and bridled together and weighted by an adjustable lever weight. By this means for about 40's we can, and do, easily get, say, about 30 lb. on the front roller, $4\frac{1}{2}$ lb. on the middle roller, and $7\frac{1}{2}$ lb. on the back roller, there being six ends to a roller, as is the common

practice. For fine counts, out of Egyptian and Sea Islands cotton the rival system is found to be best, and is almost universally adopted in the Bolton district. The front roller is dead weighted, and the back and middle rollers are self-weighted. For single thread boss rollers, with two threads to each roller, as is the common practice, there may be for

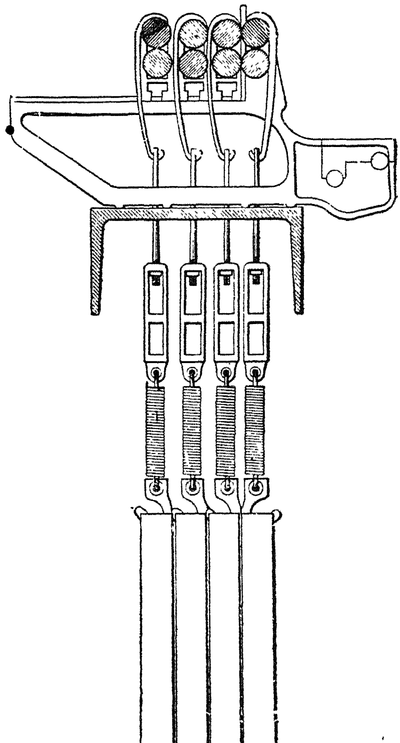


FIG. 19.

about 60's, say, 6 lb. on the front roller, the middle roller may be $\frac{3}{4}$ lb. in weight, and the back roller may be $1\frac{1}{2}$ lb. in weight. This lends itself more readily to the big drafts and long stapled cottons which are used.

METALLIC ROLLERS.[1]

Referring to Figs. 19 and 20, there are shown the weights suspended through the medium of the springs, hooks, and links from the ends of the top rollers.

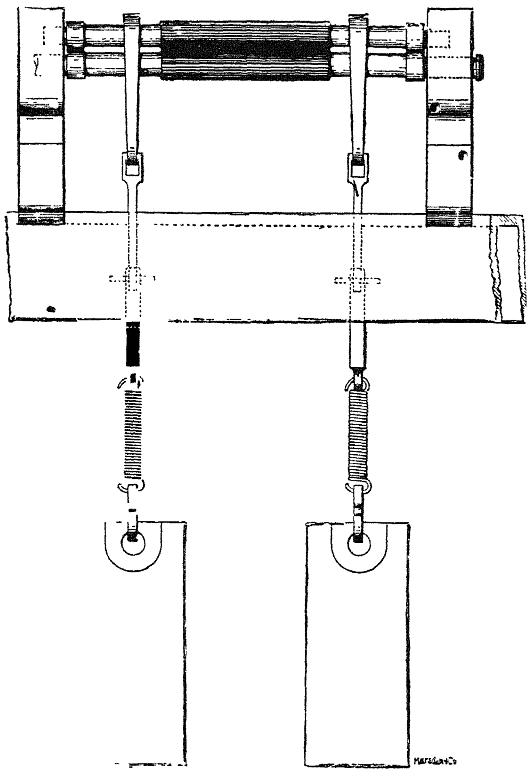


FIG. 20.

The springs are not always used even on drawframes, and seldom or never in later processes. As stated, they serve the

[1] Metallic rollers are often used on sliver lappers, ribbon lappers, in the drawbox of the comber, and on the drawframes.

useful purposes of absorbing vibration and tend to prevent disturbance to the rollers in this way.

Figs. 19 to 21 are intended more especially to give an idea of the construction of what are termed metallic drawing rollers, which have been adopted in very many mills for drawing frames in lieu of the usual leather-covered top rollers.

The top and bottom rollers are fluted to an equal extent, as shown (Figs. 21 and 22), and the points, *b*, of the flutes of one roller penetrate the spaces of the other. The hardened

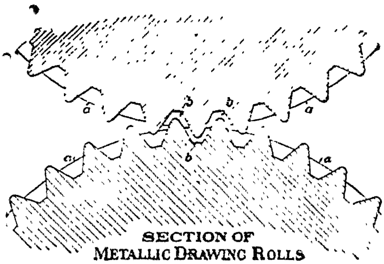


FIG. 21.

steel collars at *a*, however, limit and determine the amount of this inter-meshing of the flutes. The cotton, in passing between the rollers, penetrates the flutes, and the bottom rollers drive the top almost the same as one wheel drives another.

Metallic drawing rollers save the trouble and expense of

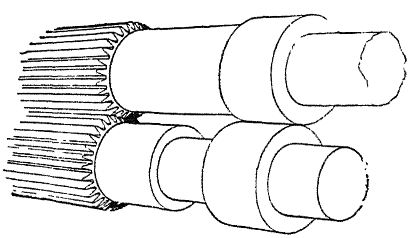


FIG. 22.

roller leather, and at the same surface speed give increased production, due to the penetration of the cotton into the spaces. The cotton is given a crimped appearance by the flutes, which, however, is not proved to damage the fibres. It is becoming

the more general practice to have the back lines of rollers more deeply fluted than the others. Opinions appear to be pretty equally divided as to the merits and demerits of these rollers.

Q. 1900. Describe in full detail the method of weighting the top rollers of drawing frames. What results if they are weighted either too heavily or too lightly? At what point should the greatest weight be applied, and why?

A. There are two methods of weighting drawframe rollers, which are in extensive use, *viz.*, the lever method and the dead-weight method. Figs. 23 and 24 show the lever method, while Figs. 19 and 20 show the dead weighting.

Taking the latter method, the weight in some cases is hung from the middle of each roller, while in other cases it is suspended from each end of the roller. There is a double hook resting on the roller at the top, and having a link hooked on its lower extremity. The link sustains a wire hook, to which is placed the weight. The arrangement is practically the same for all the four lines of rollers. As shown in Figs. 19 and 20, occasionally short spiral springs are interposed between the weights and the hooks in order to take up the shocks caused by unequal thicknesses of cotton going through the rollers. If the rollers are weighted too lightly there is a tendency for the cotton to be drawn unequally and to be plucked through, and to come out too coarse, through the fibres not being gripped firmly enough. With too heavy weighting there is a tendency to damage the fibres of cotton, and also the leather covering of the top rollers.

In all the processes subsequent to the drawframe the front roller is always by far the most heavily weighted, because this roller has to do by far the greatest amount of drawing out of the cotton.

In the case of the drawframe, however, there is a curious difference of opinion as to which of the four pairs of rollers should be most heavily weighted, and practice varies in this respect. Probably the most common practice is to weight each of the four lines of rollers equally.

In some cases each leather roller is weighted with a 36 lb. weight, 18 lb. devolving on each end of the roller, and each line of rollers being weighted the same.

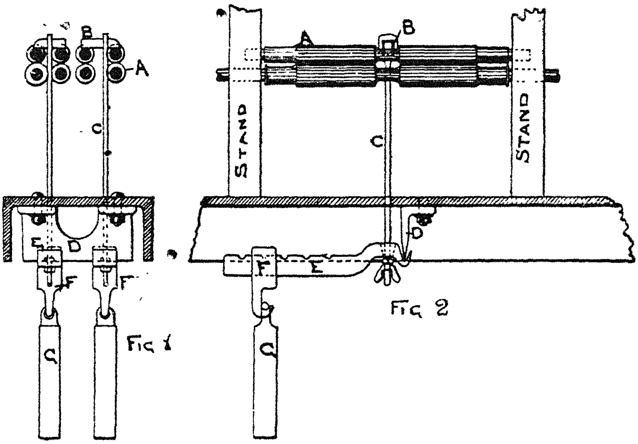


Fig. 23.

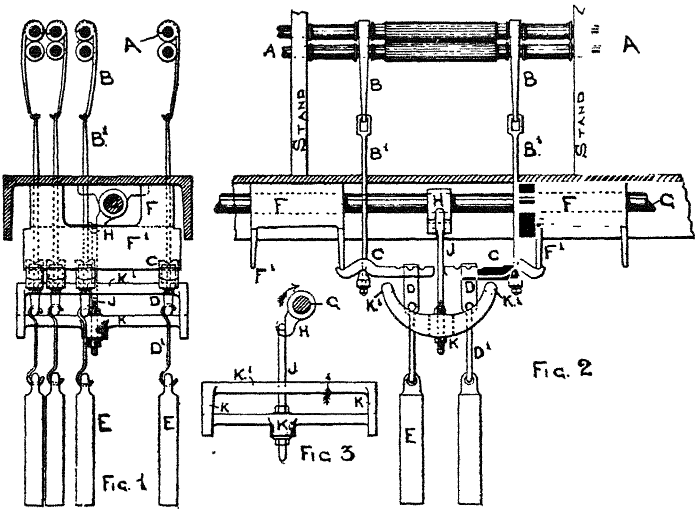


Fig. 24.

Lever Weighting of Drawframe Rollers.

As stated, in some districts, such as Oldham, many people appear to prefer the lever style of weighting for drawframe rollers. Figs. 23 and 24 show two methods of lever weighting.

At Fig. 23 is shown the most usual form of lever weighting as applied to the middles of the rollers, the same method being also applicable to the ends of the rollers.

In Fig. 23 in No. 1 we have an end view, and in No. 2 a back view. In each case at A are the rollers, B are the saddles, C the hooks, D is the fulcrum, E is the lever, F is an adjustable hook capable of being placed in any of the notches on E, while at G are the weights.

At Fig. 24 is shown a method of lever weighting to which has been applied a weight-relieving motion, and it may be stated that both methods are made by Messrs. Hetherington of Manchester. Fig. 24 also shows lever weighting as applied to the ends of the rollers. In Fig. 24 :—

No. 1 is a section of frame, showing rollers, etc.

No. 2 is a front view of part of drawframe.

No. 3 shows the motion for relieving the weight from the rollers.

Assuming the weight to be 6 in. from the fulcrum, and the weight-wire 1 in. away, the weight being 10 lb., we get:—

$$\frac{10 \times 6}{1} = 60 \text{ lb.}$$

weight on the roller middle.

Index of Parts. (Fig 24.)

A are the rollers; B and B^1, top weight hooks or hanger wires: C, C, are the levers; D, D^1 are the bottom weight hooks from which are suspended the weights, E. In each case F is the fulcrum plate for the lever, F^1 being the fulcrum; G is a shaft for relieving motion, running the length of the frame; H is a hook lever fastened to shaft, G. At J is an adjusting hook, carrying the frame, K; K is the weight-relieving frame; K^1 ends of frame. As stated, the particular method shown is Hetherington's, who sometimes place a lever to the shaft, G, or a worm and quadrant for moving the shaft,

G, in the direction shown by the arrow. In doing this they raise the hook levers, H, J, K, until the ends of the frame, K, come in contact with the underside of the lever, C, and, forcing this upwards, releases the rollers of the weight, which rests on the frame ends, K^1.

Lever *v*. Dead Weighting.

As stated, there is a difference of opinion as to which is the better method of weighting. It will be very interesting to note that almost exactly the same difference of opinion has existed for a good part of a century. About 1836 James Montgomery wrote on this point as follows; "It has often been disputed whether the drawframe should be fitted up with dead or lever weights. Upon this subject a considerable diversity of opinion exists amongst managers. The dead weight is doubtless the more solid and uniform, as it always acts the same; whereas the lever acts with a kind of vibratory motion, caused by the shaking and agitation of the machinery, together with the inequalities in the body of the cotton that passes through between the rollers. Dead weight is only adapted for fine, light cotton; for when there is a heavy body of cotton, that is long and strong in the fibre, passing the frame, it requires a very great load of dead weight suspended from the rollers to make it draw equally; whereas the other, by shifting the weight upon the lever, can be adjusted to suit either heavy or light cotton, and therefore it is preferable to the dead weight."

Q. 1900. Describe and sketch the roller stands used in a drawing frame. Give full details of their construction and the method of setting the rollers.

A. The roller stands on all the machines constitute the bearing surfaces for the drawing rollers, and are in every case secured to the roller beam. The beam extends the full length of the machine, and the stands are fastened to it at short intervals so as not to leave much length of roller unsupported. On account of four pairs of drawing rollers being used on a drawframe, as against three pairs in all the subsequent machines and because also of the large diameter of the rollers, it is common to have the drawframe stands made with double supporting pillars. A bridge or cross piece reaches from one support to the other, and on this

bridge the four pairs of rollers are adjustably secured. It is noteworthy that on a drawframe—at any rate in many cases—a pair of top and bottom rollers are sustained by the same bearing and both rollers are adjusted together, and it is not possible to adjust one without the other. When it is required to set the rollers, a gauge of the proper thickness may be inserted between the rollers, or, in some cases, the bearing surfaces, and the supports are made fast in that definitely regulated position.

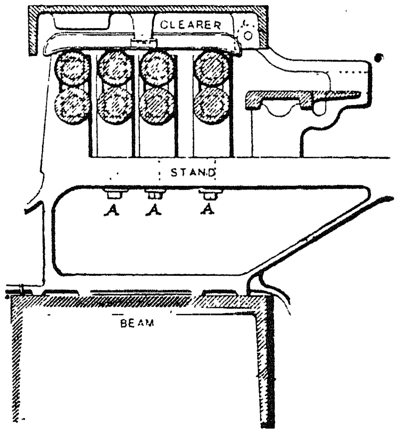


FIG. 25.

Referring to Fig. 25, any line of rollers may be adjusted by means of screws, such as shown at A, A.

LOOSE ENDS TO ROLLERS.

After an extended experience we recommend the adoption of loose ended top rollers instead of the ordinary loose boss roller as being superior to and possessing all the advantages of the latter. These loose ended top rollers afford special facilities for being more easily, quickly and cleanly oiled, there being no necessity for removing them from their places nor stopping the machine for this purpose, consequently there is less cause for their being neglected; in addition, there is to some extent less friction by this system of top rollers with loose ends or bushes.

Q. If 2 yards of carding weigh 100 grains, the number of slivers put up 6, the draft in drawframe $6\frac{1}{2}$, what will be the weight of 1 yard of drawing?

A. $100 \div 2 = 50$ grains = weight of one yard of card sliver. This is made lighter in proportion as the draft is greater than the number of the doublings, therefore we get:—

$$\frac{50 \times 6}{6\frac{1}{2}} = 46{\cdot}15 \text{ grains.}$$

Q. A drawframe containing three heads of six deliveries each has a front roller $1\frac{1}{2}$ inch diameter running 260 revolutions per minute, and is producing a sliver of 40 grains per yard. How many pounds will the drawframe produce in a week of $56\frac{1}{2}$ hours, the time actually run being 45 hours?

A. $$\frac{260 \times 3 \times 22 \times 60 \times 45 \times 40 \times 6}{2 \times 7 \times 12 \times 3 \times 7000} = 3{,}151{\cdot}8 \text{ lb.}$$

Q. Describe how the leather coverings of the rollers are kept clean.

A. (1) Various kinds of "top clearers" are used to keep the leathers free from accumulations of fly and from what are

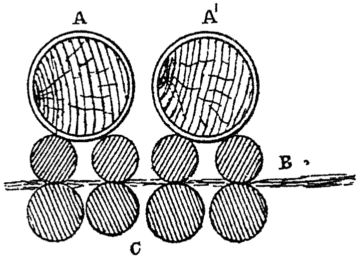


FIG. 26.

termed roller laps. The cheapest and most common clearer for drawframes consists in a piece of flannel fastened to a flat board and simply resting on the leather rollers, as shown in Fig. 25.

(2) Endless flannel ribbons having a traversing motion are in extensive use, the best known being Ermen's top clearer, which is fitted with a comb to keep the flannel automatically

clean. Very recently this has been improved by a traversing comb for the flannel being added, as shown in Fig. 27.

(3) A clearer which has received a fair amount of adoption in the Bolton district consists in two round flannel-covered rollers, one of which is driven round positively at a slow speed by small wheels and rests on the front and second rollers. The other roller rests on, and is rotated by frictional contact with the third and fourth rollers. Such rollers are shown at A, A^1 (Fig. 26), B is the cotton and C the drawing rollers.

Improved Clearer for Drawing Frames.

A neat little devicement is shown in Fig. 27. This improvement is a combination of the stationary and the "Ermen" clearer. It is an exceedingly simple device, and entirely dispenses with gearing, while at the same time the contact between the flannel and the surface of the drawing rollers is at all times assured. Instead of causing the flannel to revolve by means of a spiked roller, the inventor of this device introduces an additional comb, with fine teeth, similar to those of a doffer comb blade. This hinges loosely to the front side of the arm which carries and works the stripping comb. As the latter recedes and strips the flannel of the waste fibres, the front comb travels along with it, but the teeth therein ride loosely over the surface; on its return journey, however, the teeth enter the web of the flannel and give it a forward movement. In order that the action of the front or driving comb may not take place until the stripping comb is clear of the waste, a certain amount of play is given to the former in its attachment to the reciprocating arm.

Q. 1898. What are the means adopted to discover the fineness of a drawn sliver? Give method of computation used to determine the hank, and say upon what it is founded.

A. The practical means usually adopted for discovering the fineness of a drawn sliver is to take from two to six yards of sliver from the last head of drawing, and to find its weight by special scales. A wrapping machine one yard in circumference is usually utilised in measuring off the required number of yards. The weight having been found, the hank sliver may be found by referring to a specially compiled

table kept handy, or it may be determined by the following formula :—

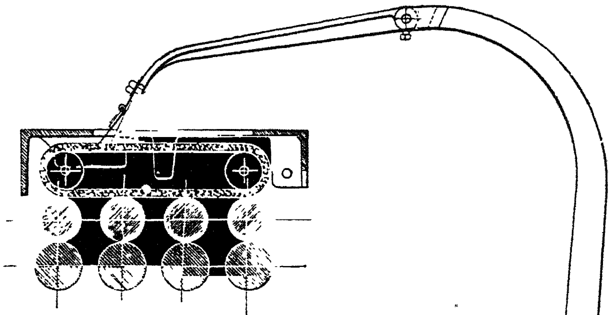


FIG. 27 A.

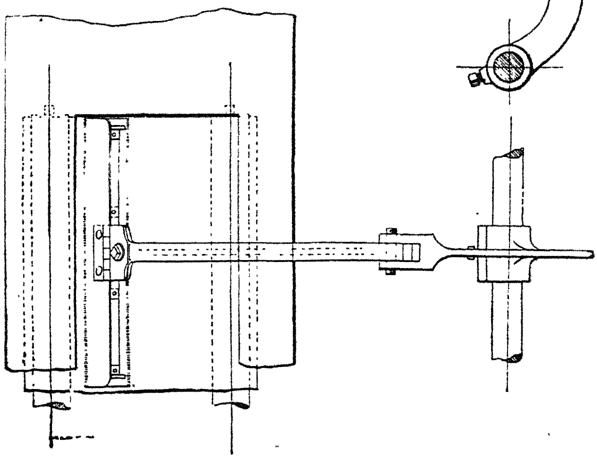


FIG. 27B.

$$\frac{\text{Number of yards} \times 8{\cdot}33}{\text{Divided by weight in grains.}}$$

Example : Six yards of sliver from the last head of draw-frame weigh 13 dwt. 10 grs. What is the hank sliver ?

$$13 \times 24 + 10 = 322 \text{ grains in weight;}$$

$$\text{then } \frac{8\cdot33 \times 6}{322} = \cdot155$$

Any such calculation as the foregoing could be worked by proportional arithmetic, and the short method given above is obtained by a simple process of cancelling certain terms which always enter into such a calculation.

Q. 1899. A drawing frame has four lines of rollers, the first roller being $1\frac{1}{4}$ inches diameter, the second $1\frac{1}{8}$ inches, the third $1\frac{1}{4}$ inches, and the back line $1\frac{1}{4}$ inches. The front roller pinion has 20 teeth, and drives a stud crown wheel with 85 teeth. On same stud is another wheel of 65 teeth, driving a wheel on back roller with 70 teeth. On the off end of the back roller is a wheel with 28 teeth, driving a carrier pinion with 32 teeth, compounded with a large carrier with 38 teeth, which drives pinion on third line with 28 teeth. On the off end of front roller is a pinion with 22 teeth, driving a carrier with 42 teeth, compounded with a pinion with 30 teeth, which drives pinion on second line with 36 teeth. Assuming the speed of front roller to be 100, what are the respective velocities of the various lines and the draft between each?

A.

Revolutions of first or front line . .	100 per min.
Revolutions of second from front line	43·65 per min.
Revolutions of third from front line	25·944 per min.
Revolutions of fourth from front line	21·848 per min.

The workings are as follow:—

(1) $$\frac{100 \times 22 \times 30}{42 \times 36} = 43\cdot65 = \text{second line.}$$

(2) $$\frac{100 \times 20 \times 65}{85 \times 70} = 21\cdot848 = \text{back line.}$$

(3) $$\frac{21\cdot848 \times 28 \times 38}{32 \times 28} = 25\cdot944 = \text{third line.}$$

Drafts—

(1) $$\frac{25\cdot944}{21\cdot848} = 1\cdot187$$

(2) $\dfrac{43\cdot650 \times 9}{25\cdot944 \times 10} = 1\cdot512.$

(3) $\dfrac{10 \times 100}{9 \times 43\cdot65} = 2\cdot29.$

Q. 1899. What is the object of a stop motion in a drawing frame? At what points does it act? Describe and sketch any motion with which you are acquainted.

A. The great object of a stop motion on a drawframe is to automatically knock off or stop the machine upon the fulfilment of any one of three or four conditions, thus preventing waste and single.

The points at which a stop motion may act are as follows: (1) At the back of the machine before the slivers reach the back leather roller. Suppose a sliver to fail from any cause, then in the mechanical stop motion one end of a spoon lever drops down, and acts so as to release the stop rod, so that the driving belt is moved upon the loose pulley by a strong spiral spring.

(2) When an end fails or runs light at the front of the frame, between the front rollers and the trumpet, practically the same actions take place.

(3) When the front cans are sufficiently full of sliver it is usual to have the machine knocked off by suitable mechanism, to ensure that each can shall have the same length of sliver in it.

(4) Sometimes a frame may be made to knock off when the sliver runs too thickly or heavily at the front of the machine, and sometimes when a roller lap is made, the latter applying more especially to the electric stop motion.

THE ELECTRIC STOP MOTION. (FIG. 28).

About 1876 Messrs. Howard & Bullough began to apply the electric stop motion, and it has been very successfully applied to most of their drawframes ever since.

It dispenses entirely with the spoon levers of the mechanical stop motion, of which there are very many in every spinning mill, fitted with mechanical stop motion. For instance, in a mill of fine counts doubling eight ends up together and passing the same cotton through three different heads of drawing, each of six deliveries, there would be

8 × 6 × 3 = 144 back spoon levers, each one independent of the other, and having to be looked after by one tenter.

The electric stop motion depends for its action on the fact that cotton in a dry state is a *non-conductor* of electricity. The current may be obtained from a small electro-magneto machine.

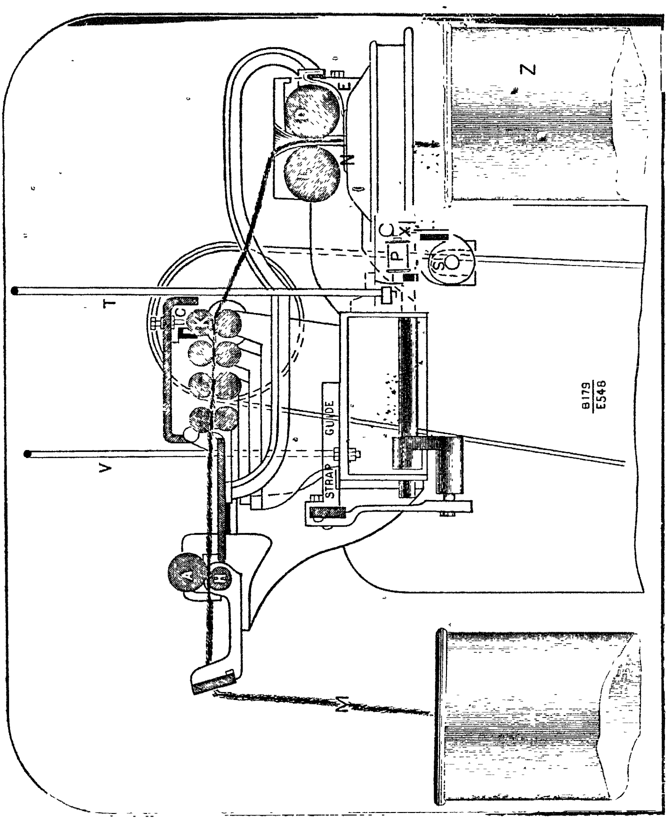


Fig. 28.

Fig. 28 is a section of this motion.

The first stop is for sliver breaking at the back. The slivers on their way to the fluted drawing rollers pass

through rollers, A and H, which may be described as "electric rollers". The bottom roller is fluted and runs in bearings on the frame. The top rollers are made short, and each rests upon a pair of slivers. They run in brackets on the back plate, which is electrically insulated from the rest of the frame, as therefore also are the top rollers. The effect is that the top rollers are in communication with one pole, whilst the bottom rollers are in communication with the other pole. If they touch each other the circuit is completed, and the current will pass and give attractive power to the magnet. This, therefore, occurs when the sliver breaks and allows them to come in contact. At one end of the machine is the electro-magnet, P, which, when the current passes, becomes operative and attracts a pendulum catch, X, within the range of revolving cam, S, and causes this to actuate the belt-shipper and stop the frame. For the stop motion, if the sliver breaks in front, after passing the drawing rollers, the calender rollers, L and D, are utilised. They are insulated from each other, and when they come in contact by reason of a breakage of the sliver the current passes, as before described, through the magnet and stops the machine. Suppose, further, the sliver at this point is only partially broken, and therefore runs light. The cotton not passed on will collect in front of the rollers, and will either choke the funnel over the coiler or lap on the front drawing rollers. In the former case the end will break, and so cause a stoppage, and in the latter case a stoppage will also be caused, but in the following way: It may lap on either of the front rollers, but no matter which, they will be separated, the roller, K, being lifted up until it makes contact with the set pin, C, of different electrical pole, when the current passes and a stoppage results. Therefore, not only is a broken end at the front met directly, but if the sliver run light, by being partially broken, it also provides indirectly a stop motion for such eventualities. For the full can stop motion, when the can is sufficiently filled, it slightly lifts the tube wheel and completes the circuit, when a stop results as before. It will be noticed that this is equally so for all the deliveries, there being an independent stop for each, and therefore there is no risk of breakages from overfilling, as when a stop motion is applied to one coiler only and taken as a guide for the others. The stoppage is instantaneous and absolutely certain.

No sooner is the circuit made, by two parts of the opposite poles touching, than the current passes, and the strap is shifted, and hence, from the certainty and rapidity of the action, machines can be worked with advantage at a quick rate of speed, and without the risk of making large quantities of waste. These four electric stop motions are all acquired by the mere contact of two surfaces. As to two of them—the back and front stop motions—it is the absence of the cotton which causes the metallic surfaces to touch. As to the other two—the roller lap and the full can stop motion—it is the presence of too much cotton which raises one surface in contact with its electrical opposite surface, which contact, by causing the magnet to operate, instantly stops the machine. Mere contact, mere touch of two dead or plain surfaces, is sufficient to produce the effect. Hence, these four stop motions add little to complicate the machine. It may be added that it is possible to apply the roller lap stop motion to the second, third, and fourth rollers as well as to the front line. Also, for the full can stop-motion, it is possible to use a screw arrangement for making the electrical contact; or yet again, a hunter cog-wheel arrangement.

The Mechanical Stop Motion.

The mechanical stop motion, as made by Messrs. Hetherington, is fully described below. The several illustrations are grouped together under Fig. 29, and are individually numbered in addition.

The stop motion spider shafts, front and back, are driven by the incline clutch C (Fig. 6), which, so long as the shafts turn easily, is kept in gear by the counterpoise, D. When the shafts are stopped by the falling of a tumbler the clutch is thrown forward, and the counterpoise rising, lifts the bar, B, out of the notch in which it rests and allows the spiral spring to throw the strap on to the loose pulley.

The front stop motion can be adjusted with great nicety, acting when a sliver is too heavy, as when a piece of clearer waste comes forward, and also when a sliver is too light, as when a roller lap occurs. Referring first to the front stop motion, the spoon, E (Figs. 7 and 8), pivots on two pointed projections cast on its underside, and carries a pendant at the

back, hanging free. When the machine is working, the spoon, E, is drawn down at the front till the projection at the end of the pendant meets the underside of the lever, L (Fig. 8), which is prevented from rising by the balance weight, P, which can be adjusted nearer to or farther from the pendant to suit different thicknesses of sliver, but if the trumpet gets stopped, as by a piece of clearer waste or too heavy a sliver, from whatever cause arising, the resistance of the weight, P, is overcome and the right hand end of the lever, L, is thrown down into the spider, M (Fig. 8), stopping the machine. On the other hand, if the sliver is too light the spoon, E, falls back under the influence of the pendant, K, which then engages in the left hand spider, M, also stopping the frame.

The *back stop motion* tumbler pivots on the upper knife edge of the bar, O (Fig. 9), which is a fixture. The lower end of the tumbler just passes under the bar, and when the tumbler falls this offers a solid resistance. When the machine is at work the weight of the sliver keeps the upper end of the tumbler against the bar, O, which can be adjusted in the direction of its breadth so that the lower end of the tumbler just clears the revolving spider, and the slightest displacement of the tumbler stops the frame.

Single Preventor Roller.

Without this roller the back roller must raise the sliver from the bottom of the can and drag it across the stop motion tumblers so that the rupture of the sliver almost invariably takes place close to the back roller, and the weight of the broken end resting on the tumbler retards if it does not completely prevent the action of the stop motion, and the other has already passed into the rollers before the machine is stopped. To obviate this defect there is applied an extra feed roller, H (Fig. 5), placed over the centre of the cans and a little above them, thus reducing the danger of stretching delicate slivers. The slivers being thus fed to the back roller over to the stop motion, which lies between the two rollers, no rupture can take place unless before the feed roller, consequently the broken end of the sliver never reaches the tumbler before the machine is at a standstill. A great advantage of this system is that the attendant has both hands free when piecing, one to put up the sliver and the

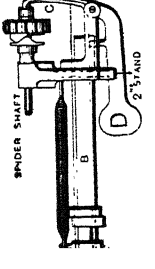


Fig. 6.

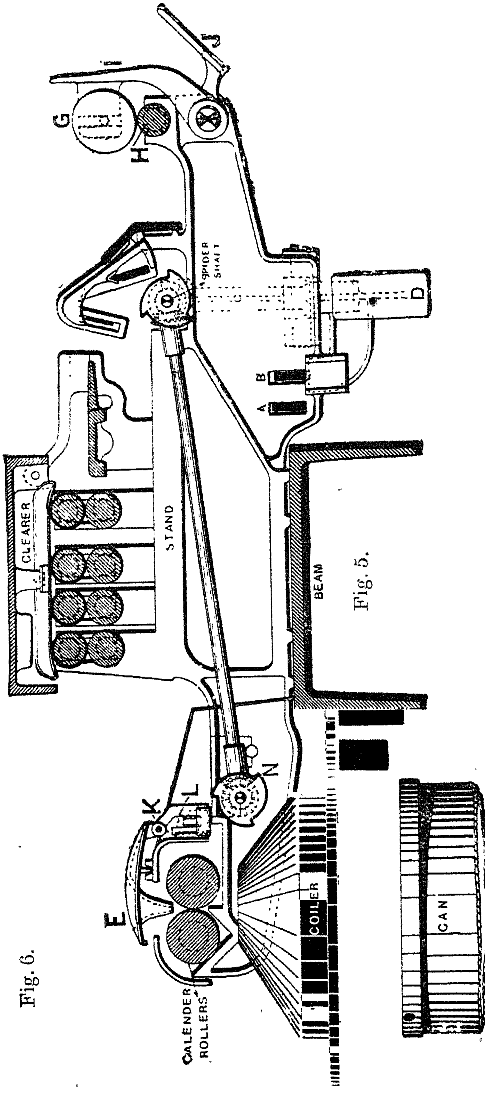


Fig. 5.

FIG. 29.

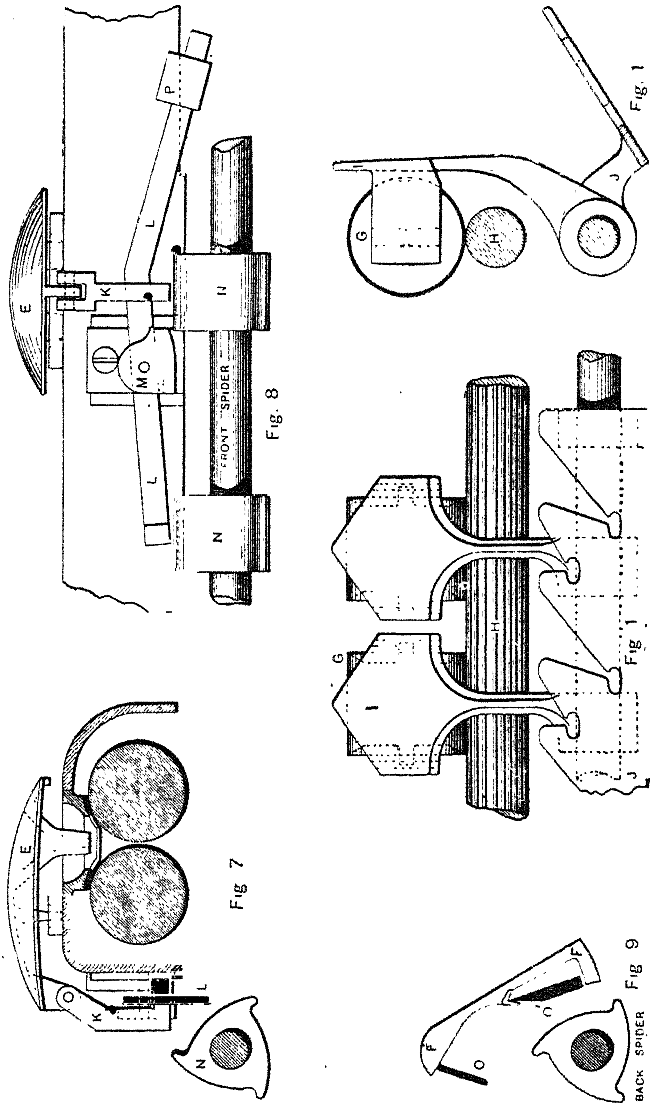


FIG. 30.

other to set on the machine, as the top roller, G (Fig. 29), never requires to be lifted, as owing to the form given to the

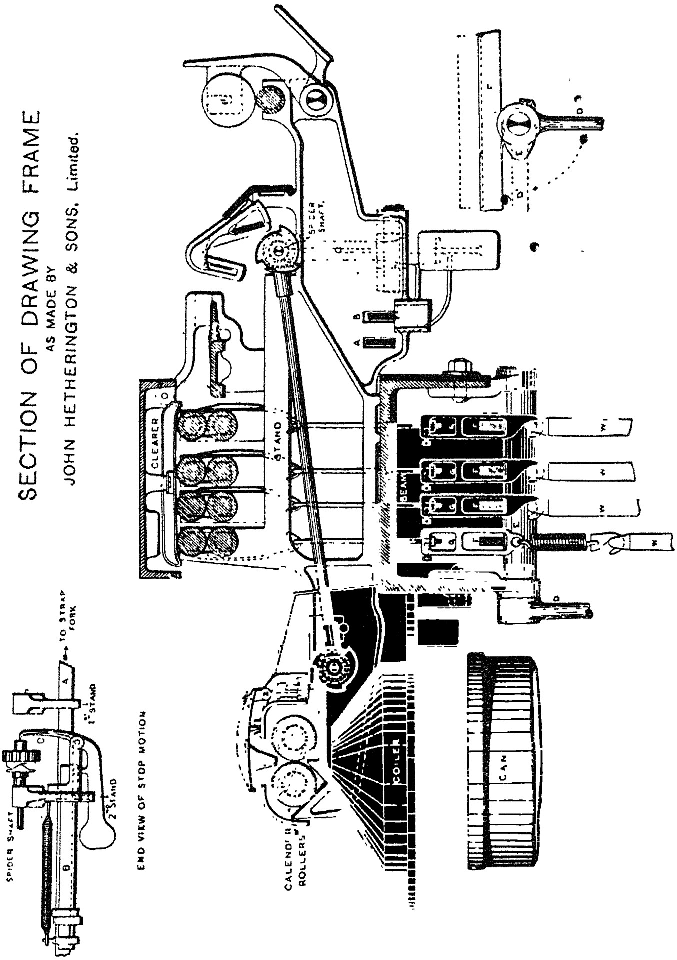


Fig. 31.

bracket, I, which carries the roller, the sliver passes naturally and of its own accord under the roller. In other respects

these several sketches referring to the mechanical stop motion are largely self-explanatory.

Weight-relieving Motion. (Fig. 31.)

It has become a common practice to apply simple contrivances by which the heavy weights of drawframe rollers can be readily relieved from the rollers by the mere pulling of a handle or lever. Fig. 31 is designed to show such an apparatus. The little sketch on the right hand of Fig. 31 especially aids in showing the method of relieving the weights from the rollers.

Referring first to this small sketch, the handle at D is in

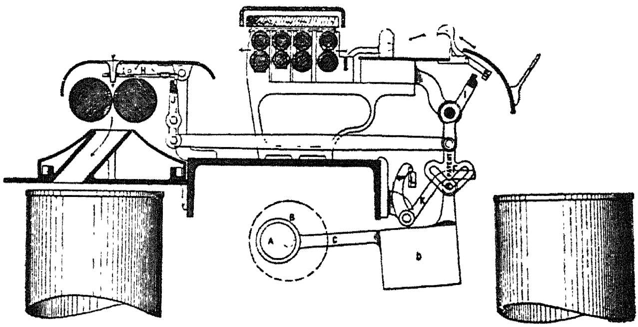


Fig. 31a.—Stop-motion for Asa Lees' drawframe.

working position. By pulling this handle into the horizontal or dotted position the cam, E, is brought to the underside of the bars, F, thus raising them until they come into contact with the bridge, G, in which position the cam relieves the weight from the rollers. The weights are marked W, and the front roller only is shown with cushioning spring fitted to its weight.

Tandem v. Zigzag.

In most cases the cotton slivers pass through three heads of drawframe arranged on either one or the other of two methods. (1) Tandem method, in which one head or frame is placed behind the other; (2) Zigzag method, in which the three frames are in one straight line.

6

Asa Lees' Drawframe Stop-Motion.

The motion illustrated above is worked from the coiler shaft, a wheel on this shaft gearing with one mounted on a stud, the latter wheel having an eccentric A cast with it. Round this eccentric is a clip B, cast along with the eccentric arm C and weight D, which has a stud E attached. This stud enters a V-shaped slot in the lever F, the weight D keeping it in the bottom of the slot so long as the shaft G is free to oscillate. When, however, the oscillation is prevented, either by the hooked end of the spoons, or by the trumpet levers H coming in contact with the knocking-off levers I or J, the stud E ascends one side of the V slot and lifts one end of the bell crank lever K, thus causing the other end to free the slide bar L; a spring then pulls the latter, and forces the strap from the fast to the loose pulley.

It will be seen that immediately a sliver breaks, the shaft G is prevented from oscillating, no matter in what direction it may be moving at the time, the levers I or J coming in contact with the spoon end S, or the end of lever H, when the shaft moves one way, or with the hooked portion of S or H when it moves the opposite way. This arrangement makes the motion so sensitive that the frame is stopped practically instantaneously when an end breaks.

CHAPTER III.

BOBBIN AND FLY FRAMES.

Q. Describe the functions of the slubbing, intermediate, and roving frames.

A. (1) One of the most important duties of these machines is to reduce the sliver from the drawframes to a sufficiently thin or fine substance to suit the final spinning process. This work is done by the repeated action of the drawing rollers in one machine after another.

(2) A second important duty is to wind the attenuated roving or cotton upon bobbins of a size convenient to suit the next succeeding process.

(3) At these machines the cotton becomes so attenuated as to require a certain amount of twist to be definitely inserted into the thin strands of cotton, and this is a third important duty of these machines.

(4) In order to ensure regularity of the finished yarn it is the custom to put two ends up together at the intermediate and roving.

It may be added that incidentally the rollers have a slight tendency to free the cotton from any fine impurities that may still be in the cotton. Such impurities fall out when the cotton is drawn out by the "draft" of the rollers.

Also it may be stated that every set of drawing rollers tends to make the fibres of cotton more parallel if possible.

Briefly, then, the principal functions of these machines are to attenuate, twist and wind on the cotton.

Q. 1898. What machines constitute the series used for producing coarse, medium and fine rovings for spinning? State fully in what particulars they differ from each other. Define "gauge" as applied to these machines.

A. Subsequent to drawing, the machines used for the

production of rovings are as given below: For coarse counts, the slubbing frame and a large bobbin roving frame; for medium: slubbing, intermediate, and roving frames; for fine: slubbing, intermediate, roving and jack frames; the slubbing frame differs from all the others in having cans placed behind it instead of bobbins, and no doubling takes place at this machine; while the others nearly always have two ends doubled together to produce uniformity. At the slubbing frame a slowly revolving tin cylinder is employed to draw the slivers from the cans. Further than these distinctions, the chief differences between one machine and another of the series simply consist in practically all the parts, such as rollers, spindles, collars, bobbins, being less for each succeeding machine that the cotton comes to. "Gauge," in the spinning machines, means the distance from centre to centre of adjoining spindles; but this definition is rather awkward on the fly frames, because of there being two rows of bobbins and spindles. It is therefore often denoted as so many spindles in so many inches, this including both back and front rows of spindles. The gauge for the various machines under discussion may be as follows:—

Slubbing frame, 4 spindles in 19 inches.
Intermediate frame, 6 spindles in $17\frac{1}{4}$ inches.
Roving frame, 8 spindles in $20\frac{1}{2}$ inches.
Fine jack frame, 8 spindles in $17\frac{1}{2}$ inches.

The "gauges," however, are variable within certain limits, and are closer for fine than for coarse counts.

Q. 1899. How many speed frames would you use if you were producing rovings for (*a*) 16's yarn from Indian cotton, (*b*) 36's twist from Orleans, (*c*) 60's from carded Egyptian cotton, (*d*) 120's from combed Egyptian? In what cases would doubled rovings be used? State briefly why.

A. (*a*) In actual practice it is probable that two speed frames would be mostly used for 16's yarn from Indian cotton, three processes of fly frames for the American cotton, and three for the 60's carded Egyptian. As regards the 120's combed Egyptian cotton, practice appears to be pretty equally divided between the use of three passages of fly frames and four.

The greater number of passages are used for the finer counts, on account of the greater amount of attenuation or

drawing-out of the cotton required, rendering it advisable to spread the work over more machines. If an excessively large draft is put into any one machine, it tends to spoil the work and make roller laps and waste.

It may be added that sometimes three passages of fly frames are used for 16's counts or lower, but this practice is scarcely necessary, except perhaps in the case of very high qualities of yarn.

(*b*) In regard to the second part of the question, at the mule double roving would be always employed for the 120's, and almost always for the 60's Egyptian, while single roving would be always used for the 16's Indian, and almost always for the 36's American. Double roving is used in order to give a more uniform and therefore a stronger yarn, but is much more expensive than single roving for the same counts

Q. In some Bolton mills an additional fly frame is introduced between the spinning and drawing process. State the reason of this, and briefly describe its difference from ordinary fly frames.

A. In the spinning of very fine counts there is a danger of getting excessively high drafts in the various machines, and the extra fly frame is introduced principally to obviate this. An extra doubling is also thus obtained, and the bobbins for the mule are sometimes made very small and suitable for the delicate nature of the fine roving.

The principal difference from ordinary frames—apart from the smaller construction of the various parts—consists in such bobbins being often made without pressers. The disuse of the presser finger takes away a guiding force for the roving, which makes it somewhat difficult to make the cones of the bobbins without overrunning at the ends. To meet this sometimes flanged bobbins have been used to a moderate extent. During recent years the practice has increased of making a 7 inch lift bobbin and using a presser even for fine rovings.

Q. 1901. Why is it necessary in a slubbing frame to use a spindle and a flyer? What becomes of the twist thus imparted? Describe the change in the sliver after its passage through the machine.

A. At the delivery of the slubbing frame the cotton has become so thin and soft that it is necessary to introduce special mechanism for disposing of and arranging it in a form suitable for the creel of the next process. At the same time,

and partly for the same reasons, it is also necessary to introduce mechanism for putting a definite and regulated amount of twist in the cotton. After repeated and extended practical experiment with various arrangements of mechanism for these purposes, the bobbin and fly frame—in its essential features much as we have it now—became the established and generally adopted machine for the purpose.

The spindle and flyer are the main factors for putting the twist into the roving, while at the same time the flyer greatly aids in the guidance of the roving, and the spindle sustains the bobbin in position. The twist which is thus imparted is almost all taken out at the immediately succeeding machine. Comparing the cotton as it is fed to the slubber with the cotton as it is delivered, the principal difference is that the cotton fed is about four times as heavy for any given length as the cotton delivered, this being brought about by having a roller draft in the slubber approximating to about four. The cotton is fed to the machine out of cans, but is taken from it on bobbins. The cotton as delivered contains a definite amount of twist, whereas when fed to the machine it only contains a very small amount introduced by the coiler. If anything, it is probable the fibres may be the slightest amount cleaner and more parallel after going through the slubber.

Q. 1900. Describe and sketch the upper part of a roving spindle and the flyer carried by it. How is the latter constructed, what faults are to be avoided in its construction, and how does the presser act?

A. The upper extremity of the spindle is rounded off for the reception of the flyer which is fitted on it at this point. The spindle is slotted across the top so that a pin driven through the boss of the flyer fits into the slot, thus forming a connection between the flyer and spindle, which is sufficiently firm to cause the two to revolve as one piece, while allowing of the ready withdrawal of the flyer for doffing and other purposes.

The flyer is made with two downwardly projecting legs, in which one is usually solid and the other tubular.

The tubular leg is the actual working one, the solid leg being simply a balance The roving passes through an aperture in the top central portion of the flyer, down the inside of the tubular leg, and thence round the presser to the

bobbin. It is absolutely essential that a high finish be given to the flyers—especially for the finer numbers—and they are made of close-grained material and well polished, to prevent the cotton fibre from sticking thereto. The presser finger serves the double purpose of guiding the cotton on the bobbin and hardening the latter so as to get more length on. It is sustained by a vertical limb which is loosely connected to the tubular flyer leg, and the presser finger is made to always press against the bobbin, principally by the action of centrifugal force.

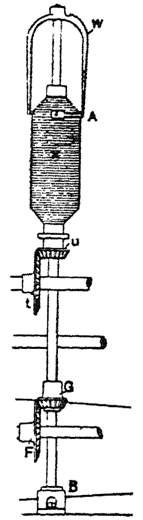


FIG. 32.

In Fig. 32 the spindle and bobbin and driving bevels are shown. F drives G fast on the spindle; t drive u loose on the spindle, but loosely connected to the bobbin x. At W is the flyer with the presser finger, A, attached to it; B is the footstep.

Q. Can more cotton be put on a short collar bobbin, or a long collar bobbin, the size of the flyer and other conditions being the same?

A. More cotton can be put upon the short collar bobbin under the above circumstances. The short collar does not go inside the bobbin at all, whereas the long collar extends up the spindle and inside the bobbin for almost the full length of the latter. This compels the diameter of empty bobbin for long collars to be greater than for short collars, and, therefore, leaves more room for cotton on the latter than the former.

Balancing of Lifter Rail of Fly Frames.

On many fly frames it is the practice to suspend heavy weights from chains behind the machine, the opposite ends of the chains being connected to the movable carriage or lifter rail. The object of this procedure is, of course, to balance the lifter rail, and make it comparatively light and easy to move about.

The chains pass round bowls attached to horizontal lifter brackets, which have lips projecting into properly shaped vertical slide pieces. The other extremities of these fingers

or lifter brackets are bolted to the lifter rail. As described elsewhere the lifter or carriage has also connected to it on the other side a number of vertical racks, which are moved up and down by rack pinions placed at suitable distances apart on the lifter shaft. The lifter shaft is alternately moved first one way and then the other by the reversing or strike bevels actuated from the cone drums. Full bobbins being much heavier than empty ones, attempts have been made to apply mechanism by which the rail should be always kept in balance. In one case a lever was tried connected to the

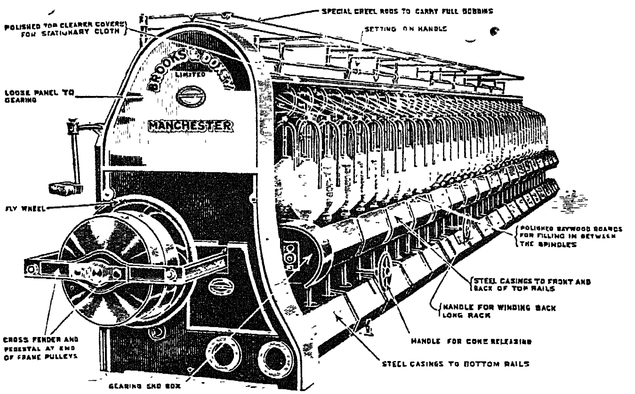


FIG. 32A.—General view of fly-frame.

lifter chains, and carrying an adjustable weight. By means of a screw and ratchet wheel the weight was moved farther away from the fulcrum as required to put more weight to balance the lifter. Such devices have not received much adoption.

LEVER BALANCING OF LIFTER RAIL.

It is considered by some that the method of balancing the top rail by weights tends to throw the rail forward and to lead to binding of the vertical slides and racks.

One method of balancing the rail by weights and levers is described in Figs. 33a, 33b, and 33c.

In this arrangement there is introduced a lever lying length-

wise of the frame and carrying the heavy adjustable balance

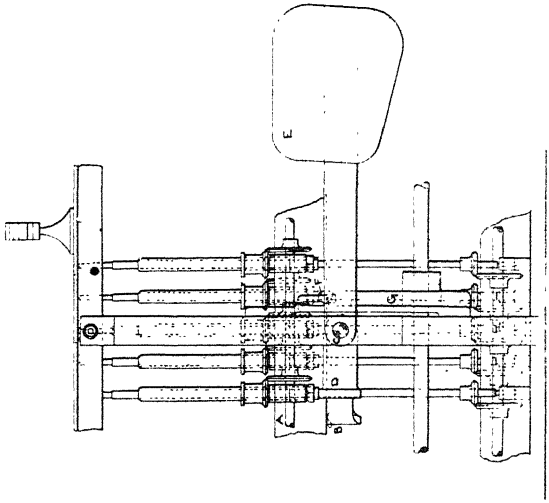


FIG. 33B.

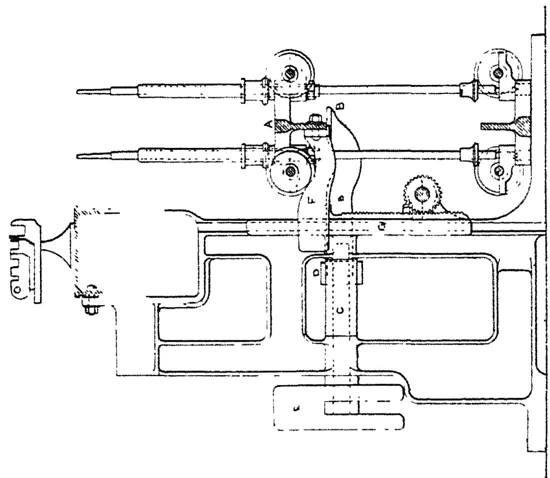


FIG. 33A.

weight, E, pivoted in the spring piece at C. A is the lifter

rail or top rail. There is no friction between the weighted lever and the rail, A, but only a rolling contact by means of the rolling surface and arm, B. At D is a pocket for arm, B. At F is the cross slide, and it will be noticed that the top rail is supported directly under its centre, which tends to give easier movement of the slides and rail, and less tendency to binding between the spindles and collars.

The two arms of the lever are in constant ratio to one another throughout the full length of the lift, so that there is no variation in the weight applied. The lifter shaft does not require to be between the spindles, but is placed behind them, so that the bottom rail can be easily kept clean.[1]

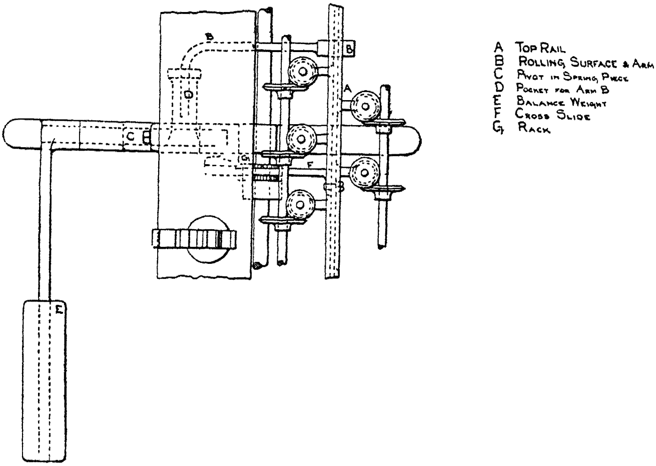


Fig. 33c.

Q. 1897. What is meant by flyer lead and bobbin lead? Say what effect the employment of either has upon the position of the cone drums.

A. By flyer lead is meant that winding is accomplished on a bobbin and fly frame by the surface speed of the eye of the presser finger being just as much in excess of the surface speed of the bobbins as is necessary to wind on the cotton as it issues from the rollers. In flyer leading the revolutions of

[1] See also the arrangement in added section to this chapter in Fig. 47.

the bobbin always increase as the bobbins get larger, so that the maximum revolutions of the bobbin are attained just before doffing, and the minimum just after doffing. By bobbin leading is meant that winding is accomplished by the surface speed of the bobbins being always just as much in excess of the surface speed of the presser finger eye as there is roving delivered from the rollers. To obtain this equality of excess surface speed the revolutions of the bobbins have to be gradually reduced as their diameters increase, so that the bobbins have their maximum revolutions just after doffing, and their minimum just before doffing; this being exactly the opposite to the case in flyer leading. The employment of either cannot have much effect on the position of the cone drums, as we are personally acquainted with a larger number of frames which have been converted from one to the other, the only alteration, so far as the cone driving is concerned, being in reversing one of the wheels, so as to drive the sun wheel the opposite way, with a corresponding alteration for driving the reversing bevels. Sometimes the introduction of the spindle lead bevel requires the bottom cone to be dropped a little. We have heard a good many people contend that the cone belt should be started at the opposite ends of the cone drums for flyer leading to what it is for bobbin leading, but this is a very erroneous idea. Whether it be bobbin or flyer leading, the cone belt always commences at the thick end of the driving or concave cone, and the thin end of the driven or convex cone drum.

Fig. 34 exhibits some of the differences between flyer and bobbin leading. A, B are the presser fingers with the cotton wrapped round them. It will be noticed that the presser finger at A is pointing to the right hand, while finger B is pointing to the left hand. A is termed a right hand flyer, B a left hand. The right hand would probably be used to wrap the cotton round A, and the left hand for B. The action is with A to *wrap* the cotton round the bobbin, and with B the cotton is *drawn* round the bobbin by the superior speed of the latter over the flyer and spindle. The thickened inside lines at D indicate a *long collar*, which passes up through the inside of the bobbin. At C is shown a *short collar*, which does not pass inside the bobbin at all.

The flyer is connected loosely to the spindle at E, E^1 by a cross bar in the flyer top fitting into a socket or cross slit in

the spindle top. The small side aperture in flyer top being out of centre with the spindle, helps to twist the cotton.

Q. Give speeds of spindles of slubber, intermediate, roving and mule.

A.

Slubber	450 to 550
Intermediate . . .	600 to 700
Roving	950 to 1,100
Mule	7,500 to 9,500

These are average speeds for medium numbers. For very low numbers the speed sometimes gets much lower on account of the small amount of twist required.

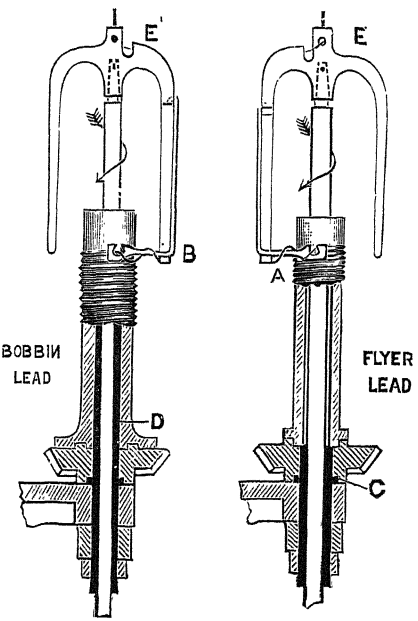


FIG. 34.

Q. Which do you consider the best, single or double press flyers, and why?

A. Experience has demonstrated the superiority of the single press, as it will do all that is required in the way of

hardening the bobbin and guiding the roving with less disadvantages than the double press. The disadvantages of the double press may be summed up as (1) greater first cost; (2) greater liability to be damaged and to get out of balance, thereby giving very unsteady spindles; (3) a little more trouble to clean, and in the way of the tenter for piecing up, etc.; (4) partly because of the above considerations in some cases more twist was required for the double pressers.

It was at first thought because one presser finger gave so much harder and better built bobbins than none, that two pressers would therefore be much better in this respect than one, but experience has not supported this view. When two pressers were used only one at a time could have the cotton wrapped round it, and as it is highly probable that the mere fact of the presser finger holding the cotton close to the winding-on point hardens the bobbin, at least as much as any other factor, this advantage is not secured twice over by using double press flyers. It is still the practice in many cases of very fine hank rovings not to use the presser finger at all. The bobbins on the outside rows are often rather softer than on the inside rows, and to overcome this some fine spinners wrap the cotton more round the flyer top or round the presser finger on the outside row.

Q. 1898. Describe any differential motion applied to a roving frame with which you are acquainted, and say what the exact effect of the rotating arm or wheel (if used) is upon the velocity of the bobbin wheel.

A. We will take Holdsworth's motion for brief description, since it is yet in use. This motion may be practically divided into two equal parts. First, there is a wheel screwed fast on the main shaft of the frame, which drives by means of two carriers the bobbin wheel. Suppose the bobbins made 1,000 revolutions per minute with the differential part stopped, and 1,050 with the latter going, then all of the 1,000 revolutions would emanate from the fast wheel just mentioned.

The other half of the motion consists of the sun wheel, which contains the bearers for the carriers above referred to, and is the rotating arm or wheel of this motion. The revolution of the sun wheel affords the variable or differential part of this motion. Taking a bobbin leading frame, every time this wheel makes one revolution, it imparts two revolutions

to the bobbin wheel, in addition to revolutions of the latter, obtained from the fast wheel of the series. Suppose, for instance, the sun wheel made ten revolutions per minute and the fast wheel 300, then the bobbin wheel would make $300 + (10 \times 2) = 320$ revolutions per minute. If it were a flyer leading frame, then every revolution of the sun wheel would take two from the bobbin wheel. For instance, in the above case, the bobbin wheel for flyer leading would make $300 - (10 \times 2) = 280$ revolutions per minute.

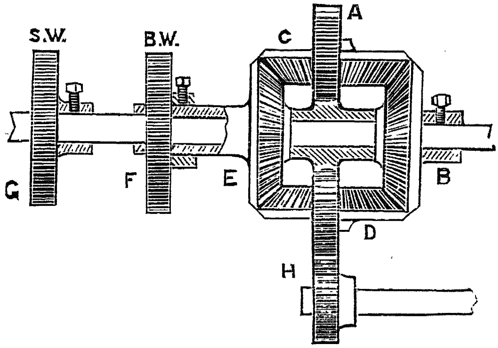


FIG. 35.

Referring to Fig. 35, wheel B is fast to the shaft, and is the principal driver of the bobbins, but does not aid in giving a variation of bobbin speed; C, D are the planet or carrier wheels; E is the driven wheel of the series, and is compounded with the bobbin wheel, F; G is the spindle driving wheel; H is the wheel which receives motion from the bottom cone and transmits it to the sun wheel, A.

DOBSON & BARLOW'S DIFFERENTIAL MOTION. (FIG. 35A.)

The essential features of this differential motion are:—

Its compactness; being self-contained and encased in a polished shell, which in outward appearance resembles an ordinary shaft coupling.

Perfect lubrication; the oil enters at T directly to the driving shaft, and after flowing into the chamber R, passes through U and lubricates the spherical bearing D and bevel wheel C. The oil also lubricates the inclined surface of E. The centrifugal action of the

Reference Letters.

A Driving shaft.
B Bevel wheel fixed on shaft A.
C Oscillating bevel wheel, mounted on spherical bearing, and gearing into B on one side and into bevel wheel S on the other side.
D Spherical bearing with long collar running loosely in the same direction on shaft A.
E Cam with inclined surface, bearing against the rim of bevel wheel C, and driven from bottom cone through jack shaft and spur wheel F.
F Spur wheel mounted on boss of inclined cam E and driving same.
G Bobbin driving wheel mounted on boss of spherical bearing D.
H Spindle driving wheel, secured to driving shaft and positively driven.
N Projections for distributing the oil.
P Teeth on oscillating bevel wheel C.
R Enlarged oil chamber.
S Bevel wheel fixed to spherical bearing and gearing with oscillating bevel wheel C.
T Oil inlet.
U Oil passage to spherical bearing.

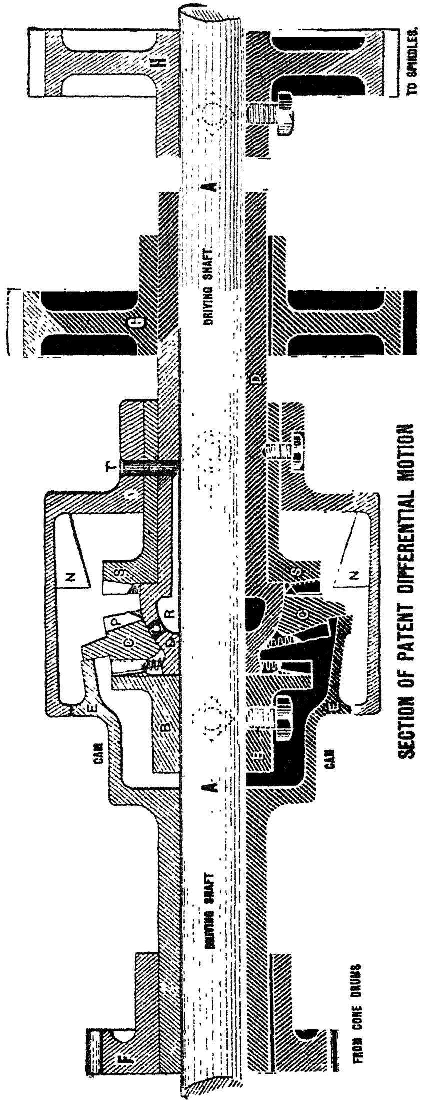


FIG. 35A.—Messrs. Dobson & Barlow's Differential Motion.

motion causes the oil to constantly circulate throughout the bearings while at work, and is equally distributed by means of the projections N.

The motion is protected from dirt by means of a casing and the cam E, which at the same time prevent the oil from flying outwards.

The gearing being thoroughly immersed in oil, little power is required to drive it.

Description. (FIG. 35A.)

Like all the other differential motions for fly frames, this one occupies the central and chief portion of the main driving shaft of the machine A. H is the first wheel for driving the spindles and really has nothing to do with the differential motion. G is the first wheel of the "swing" train of wheels for transmitting revolution from the driving shaft to the long bobbin shafts containing the skew wheels.

G is really the resultant or driven wheel of the differential motion, and is compounded with the long sleeve D, having at its opposite or internal extremity the spherical bearing D, and the bevel wheel S.

It should be particularly noted that the bobbin wheel G contains a greater number of teeth than the spindle wheel H, this being a fundamental difference between this motion and Holdsworth's. In Holdsworth's motion the two are of equal size, so that the bobbin wheel is required to always make more revolutions than the spindle wheel in order to give the excess or winding revolutions to the bobbins.

The increased size of G over H in Dobson & Barlow's motion, 63 teeth against 56, enables the excess bobbin speed to be usually obtained without G exceeding H in revolutions, even for empty bobbins.

All the parts of this differential motion—and also other patent motions—revolve in the same way as the driving shaft, contrary to Holdsworth's motion. Customary sizes of the wheels are as follows: B, 32 teeth; C, 32 on the left side and 36 on the right-hand side; S, 36 teeth; G, 63 teeth; H, 56 teeth.

It will be noticed that $\frac{56}{63}$ and $\frac{32}{36}$ are each equal to $\frac{8}{9}$, this equal proportion enabling the bobbins and spindles to be driven at equal speeds when the cone-belt is slackened and the cone-driven wheel E is stopped.

Action of Differential Motion and Calculations.

B is the only wheel of the differential that is fastened to the driving shaft, not counting the spindle wheel H.

The revolutions of the resultant and compounded wheels S, G, are obtained from the combined operation of the wheels B, E.

B working alone operates to the same value as an ordinary train of wheels, and to give $\frac{8}{9}$ of its own revolutions to the resultant wheels S, G.

The practical effect of E is to give $\frac{1}{9}$ of its own revolutions S, G in addition to the effect of B.

To demonstrate these statements more clearly, two or three simple calculations may be given and worked by the formula given below.

"Revolutions of bobbin wheel H, are equal to $\frac{8}{9}$ of the revolutions of shaft A, plus $\frac{1}{9}$ of the revolutions of cone wheel E."

Assume now the revolutions per minute of driving shaft A to be taken at 335 for a roving frame. Revolutions of cone wheel to be taken at 335 in the first case, 299 in the second case, and at nil in the third case. Determine in each case the revolutions of the bobbin wheel G.

$$\tfrac{8}{9} \text{ of } 335 = 297{\cdot}77$$
$$(1)\ 297{\cdot}7\dot{7} + (\tfrac{1}{9} \times 335) = 335 \text{ ans.}$$
$$(2)\ 297{\cdot}7\dot{7} + (\tfrac{1}{9} \times 299) = 330{\cdot}99 \text{ ans.}$$
$$(3)\ 297{\cdot}7\dot{7} + (\tfrac{1}{9} \text{ of } 0) = 297{\cdot}77 \text{ ans.}$$

The cone wheel E always has its highest speed when starting fresh bobbins and the cone-belt is upon the largest diameter of top cone drum. The amount of tumbling or oscillation of the double bevel C, depends chiefly upon the difference in revolutions between E and C, and is at its minimum usually when starting a new set of bobbins. This motion was invented by Messrs. Howarth & Fallows.

Q. 1898. Describe the construction of the swing motion in a roving frame; say what, if any, defects in the roving are caused by it during work; and give particulars of any arrangement with which you are acquainted by which they are avoided.

A. The swing motion of a roving frame is the arrangement of mechanism by which the long bobbin shafts obtain their

rotary motion from the differential motion loose compound wheel. The apparatus is so termed because the wheels, for the most part, while having circular motion, have also to be carried upwards and downwards in obedience to the movement of the lifter rail which carries the bobbins and bobbin shafts. This also has to be done in such a manner as to preserve the wheels all in proper contact with each other, despite the rolling motion. In some cases there is one carrier wheel, while in other cases there are two carriers, interposed between the compound wheel on the main shaft and the driven wheel fastened on the first long bobbin shaft. Now, it is quite evident that the fact of the driver of the series having a fixed axis, whilst the carrier, in gear with it, is carried upwards and downwards and rolled partially round it, will cause the carrier to have more or less rotary motion due to the rolling action. This motion being conveyed to the bobbins will naturally give them more or less extra revolutions, which could be easily compensated for if the lifter always moved one way and the variation were uniform. But the lifter movement being first upwards and then downwards, this rolling of the carrier will in one case give a little extra circular motion to the bobbin and take the same amount off in the other case, resulting in the rovings being stretched at one time and slackened at another.

Gaining and Losing in Bobbin Speed.

The principle of gaining and losing, and consequent alternate slackening and tightening of the ends due to the rolling motion of the carriers, was practically tested by the author some time ago. The fast bevel of the "Jack-i'th'-box" and the rollers were disconnected. The frame being started, the loose compound wheel on the main shaft, or, in other words, the driver of the swing train of wheels, was held fast to be certain that it should have absolutely no rotary motion whatever. The bobbins being empty, and the lifter having its maximum movement, and the frame being a slubber with only one carrier in the swing, there was observed to be in one lift a rotary motion of the bobbins equal to about two-thirds of a revolution in such a manner that the ends would be slightly slackened during the ascending motion and slightly tightened during the descent. In order to satisfy ourselves as to the

actual effect of this upon the roving the following calculation was made in regard to a slubbing bobbin.

The total coils of slubbing put on the bobbin were found by actual counting to be seventy, and the circumference of the empty bobbin was approximately 5 inches, these particulars giving 350 inches, put in one layer of the empty bobbin. Two-thirds of 5 inches equal 3·3 inches, total stretching or slackening to be divided out between 350 inches, which works out to every inch being pulled out to $1\frac{1}{106}$ inch in one case, and reduced in length by the same amount in the other case. It must, however, be remembered that on another frame, with different sizes of wheels, and possibly with a new patent differential motion, we might expect a slightly different result. Also the 3·3 inches of loss or gain would not be distributed equally throughout the length of 350 inches of slubbing wound on during one lift, but would be more towards the extremity of the lift and less towards the centre. On an almost full bobbin we counted forty-two coils of slubbing each approximately 19 inches long, this giving 798 inches wound on during one up or down lift. The gaining and losing of the bobbins was observed to be such that it divided out into practically the same variation as for the empty bobbin.

This answer is three times as long as would be suitable at the actual examination.

Swing Motions.

Fig. 36 shows the ordinary "swing" motion. A is on the frame shaft, and is part of the double driven wheel of the differential motion; B is a carrier giving motion to C_1 fast on the first long bobbin shaft; C_1 gives motion to a similar wheel on the long bobbin shaft of the front row of bobbins; C_2 and C_3 are other positions of the wheel C_1, which it assumes during its upward and downward motion with the lifter rail. By having only one carrier in this "swing," used along with Holdsworth's motion, there must be skew bevels of different hand used for the top rails than for the bottom ones, whereas in some cases with Holdsworth's motion two carrier wheels are used and all the skew bevels of both rails can be of the same hand.

Fig. 37 shows the compensating "swing" as made for some time by one firm. There is an extra small carrier wheel at C sustained by the special arm or lever fulcrumed at E. This arm sustains and controls the movement of the carrier wheel C, so as to produce a rolling motion which is opposite and equal to that produced by the rolling due to the upward and downward motion of the lifter rail.

Writing in 1915, it may be said that experience has shown the compensating swing to give more trouble in breakdowns,

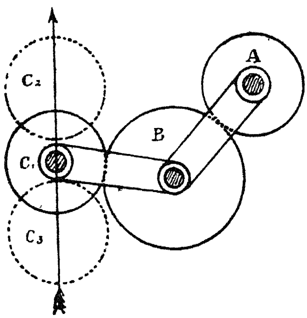


Fig. 36.

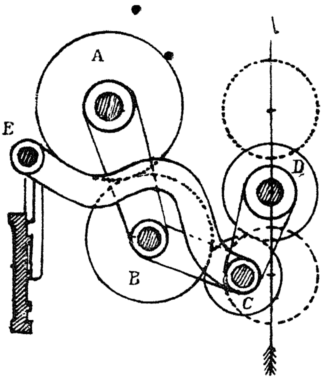


Fig. 37.

than the special merits are worth. The firm now make the ordinary swing motion. Chain "swing" motions are now favoured by some.

Chain Swing Motion.

Many people have considered the ordinary "swing" train of wheels, as described previously in this chapter, connecting the last bobbin wheel of the differential motion with the first long bobbin shaft, as an insufficiently perfect motion, and numerous attempts have been made to displace it by some different mechanical combination.

With various improvements in detail it yet retains its hold on public favour.

The alternate gaining and losing of the bobbins, the greater tendency to break down than at some other parts of the

frame, and the difficulty of making repairs and adjustments have been urged against the ordinary "swing" motion.

During recent years determined attempts to introduce chain driving arrangements in this connection have been made both at home and abroad, and one such arrangement is shown in Fig. 38 as made by Messrs. Lord, Bros. of Todmorden.

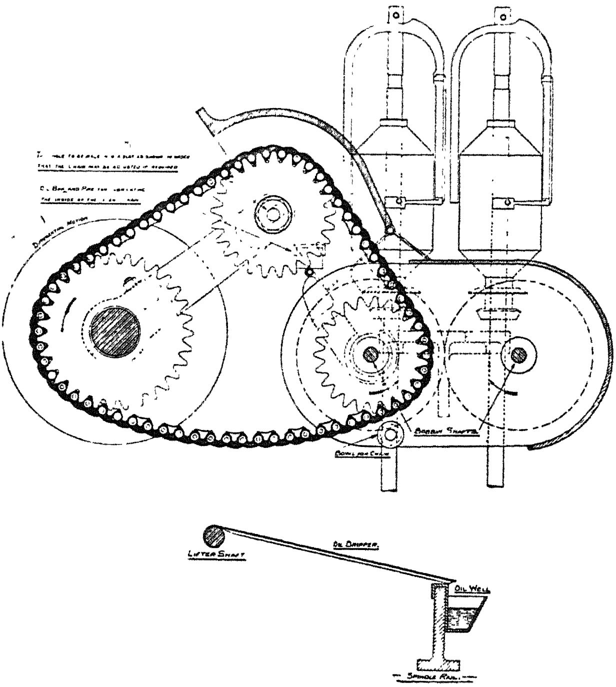


FIG. 38.

A strong sprocket driving chain is employed and passes round two carrier wheels as well as the first driving wheel and the driven one on the long bobbin shaft. The drive is positive, will transmit whatever power may be required, at whatever speed may be desired, adapts itself to the varying angles assumed, and to the varying positions of the long bobbin shafts, and does not give the undesirable gaining and losing of bobbin speed.

Q. 1901. Describe and sketch only those parts which constitute the lifting motion in a roving frame. Show how it is driven. What effect would an unsteady lift have on the building of the bobbins?

A. Fig. 39 refers to the parts principally concerned in moving the lifter rail upwards and downwards. The 51 bevel, C_1, is shown engaged with the small strike bevel of 17 teeth, which is fixed at the lower extremity of the poker shaft. It is the strike bevel which gives motion alternately to the bevels, C, C_1, according to which one is engaged with it. The long strike shaft being in this manner alternately rotated first one way and then the other, by means of the wheels, D, E, F, G, gives motion to the long lifting shaft. The small rack pinion at H engages with and drives the vertical rack, I. The rack,

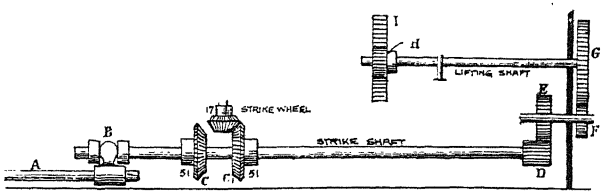


FIG. 39.—LIFTER TRAVERSE MOTION.

I, is secured to the lifter rail, and in this way the lifter or bobbin rail is moved upwards or downwards according to which bevel, C or C_1, may happen to be engaged with the strike bevel.

By means of a kind of fork at B the strike shaft is connected to the long A, which latter reaches on to the change motion. At every extremity of the lift this rod is moved longitudinally one way or the other, and puts one of the reversing bevels, C or C_1, out of gear and the other in.

There are several of the small rack pinions, H, and vertical racks, I, in the length of the frame.

The wheel D is made of double width, to enable it to always keep in gear with E, whichever way it is slided. An unsteady lift would give ridgy bobbins, and might tend to running under and over the ends of the bobbins.

KNOCKING-OFF MOTIONS.

At one time or another inventors have bestowed a vast amount of time and trouble in connection with the invention

of motions for automatically stopping bobbin and fly frames when a sufficient length of cotton has been put on the bobbins.

It is not a difficult matter at all to invent and apply a motion of this kind that will do the work in a certain fashion, and, as a matter of fact, there are many such motions.

There are two circumstances, however, which particularly make it difficult to apply motions which give entire satisfaction: (1) It is usually considered inadvisable to doff bobbins which have the broken ends of cotton near to the end of the lift of the bobbin, because the end rovings of such bobbins easily fall off and hang loose from the bobbins, and therefore make waste and give trouble in various ways. The author's own experience bears ample testimony to the fact that this is a real grievance in the spinning room. Many of the automatic knocking-off motions have only been able to stop the frame at the end of the lift, and to prevent the evil just referred to many tenters have instructions to run the frame about one-third of a complete layer more of the bobbins to get away from the cones.

(2) The second difficulty in the way of inventors of thoroughly effective knocking-off motions is that it is difficult to stop many tenters from sometimes blocking or wedging the strap-fork handles and running a few layers more to suit some purpose of their own. It is still more difficult to invent a motion that will prevent tenters from doffing bobbins before knocking-off does take place, and the present writer is not aware that any attempts have been made to solve this problem other than by watching the tenters and reprimanding or discharging them when detected. A leading idea of one motion appears to be to stop delivery of the roving slightly later than winding on, so that a few inches of slack roving are run loose on the top of each flyer ready for doffing purposes. When this is done effectively it is clear that a tenter will seldom indeed be at the trouble of winding the rovings tight again for the purpose of re-starting the frame.

It will be a good motion that quite satisfies minders and spinning overlookers, as well as the carders and tenters.[1]

Q. 1900. Describe and sketch any motion with which you are acquainted for actuating the long rack in a roving frame by which the position of the cone belt

[1] See also answer to 1910 examination question in added section to this Chapter.

is altered. Does the release of this motion affect any other part or parts than the cone belt? If so, which, and how?

A. It is usual to attach the strap forks for the cone belt to the end of a long horizontal rack, capable of being slided along to a distance equal to the length of the cone drums. Forming part of the "change motion" of the frame is a vertical shaft carrying a wheel, gearing into the long rack. Wrapped round a small drum on this vertical shaft is a chain, suitably carried by a guide pulley, and having a weight secured to it which is always trying to pull the vertical shaft round. During the length of any one lift the detent levers of the ratchet wheel prevent any motion of these parts; but when one of the "pigeon" levers is released at the end of the lift the vertical shaft is allowed to be pulled round for a small distance, thus giving a slight horizontal movement to the long rack and the cone belt. An identical motion takes place at the end of every lift. Geared up to the same short shaft of the change motion as the vertical shaft is the short rack or hanger bar, which is slightly moved at the same time so as to diminish its working length and shorten the lift. At the same moment the change motion also changes the reversing bevels, so that the direction of lift is altered.

Referring to Fig. 40, A is a small wheel, which at every reversal of the lift gives a slight motion to the ratchet wheel, X, by the wheels shown. A is fixed on the bottom of the upright weight shaft, and when the shaft is thus moved round the wheel B gives a slight horizontal motion of perhaps $\frac{1}{4}$ inch or more to the long cone belt rack C. The cone belt fork is attached as shown to this rack, and in this way is slightly moved along the cones at each release of the ratchet wheel X.

The chain, D, is attached to a weight, which is always trying to pull the upright shaft round, but can only do for the short period of the release of the escape motion. The hand wheel at E is used to wind the cone belt back again to the thick extremity of the top cone when doffing takes place.

Q. 1900. Why is the lift of the bobbin rail in a roving frame regularly shortened? How is it obtained, and what faults would occur if (*a*) its motion was irregular; (*b*) it moved too slowly; (*c*) it moved too quickly?

A. The lift of the bobbin rail is shortened at every change by the effective length of the hanger bar or diminishing rod being shortened. The shorter this is the less time will be taken for the top cradle to move through its required distance, and therefore the sooner will the pigeon, or detent levers of the bottom cradle, be released, and the direction of lift be

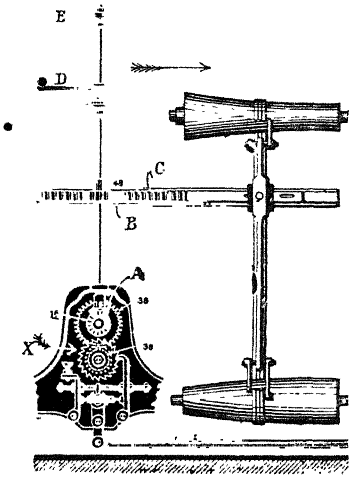


Fig. 40.

reversed. This shortening of the lift is necessary in order to make the conical ends to the bobbins. (*a*) If the lift of the bobbin were irregular, then it would build the bobbin in ridgy manner, with some of the coils of roving more or less overlapping, and there would be a tendency for the roving to run off at the extremities of the bobbin. (*b*) If the rail moved too slowly it would cause the coils of roving to be laid on each other to some extent instead of being laid side by side. (*c*) If the rail moved too quickly the opposite effect to (*b*) would take place, *i.e.*, the coils would be too far apart, tending to impart a ridginess and softness to the bobbins.

Q. 1896. Why are the bobbins on a roving frame built with top and bottom cones, and how is this formation obtained.

A. The bobbins on these frames are formed with conical ends, in order to prevent trouble and waste by "slattering," or running over and under at the ends of the bobbins. In some machines—as, for instance, the ordinary cop winding frames—the same object is obtained by using bobbins with flanged ends. In others—as, for instance, some drum winding frames—a very quick traverse is given to the yarn, and it is crossed so swiftly as to preclude the possibility of much running off at the edges. Neither of these two latter methods is practicable upon the roving frame, but the same object is efficiently obtained by having conical ends, although much less cotton is put on the bobbins with the same diameter. This peculiar formation of the bobbins is obtained by the action of the "hanger-bar" or diminishing rod, in conjunction

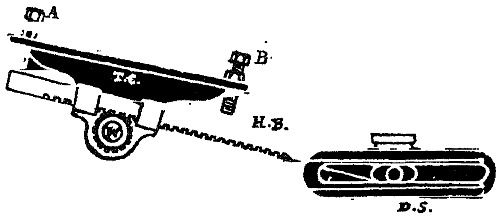


FIG. 41.

with the "change" or building motion. The "hanger-bar" at one end swivels in the double slide, which is secured to the lifter rail. The other end of the "hanger-bar" passes through two snugs in the top cradle of the "change motion". Motion is imparted to the "hanger-bar" by the vertical movement of the lifter, and is transferred from the bar to the top cradle. This upper cradle has a continuous motion, and when it has moved round a certain distance it releases, by the aid of the jack screws, the catches which hold the lower cradle, thus releasing the latter and allowing the changes to take place. Several effects are produced by the sudden movement of the lower cradle at the end of each lift. The particular effect we have here to notice is that the effective length of the "hanger-bar," or round rack, is shortened, and consequently the changes made sooner for every successive traverse of the lifter rail, which continually shortens the lift, with the natural result that the bobbins are formed with conical ends.

Referring to Fig. 41, H.B. is the hanger-bar, D.S. is the double slide, T.C. is the top cradle. The double slide, D.S., is bolted to the lifter rail, and is therefore carried upwards and downwards therewith. For a new set of bobbins the hanger-bar stud commences at the right-hand extremity of the double slide. At every change of the lift it moves slightly towards the top cradle. The effect of this shortening of the hanger-bar is that the top cradle is carried through its arc of motion more quickly, and therefore the jackscrews, A, B, release the pigeon levers of the bottom cradle sooner, thus reversing the lifter direction sooner and putting the double cones into the bobbins.

Curvature of Cone Drums.

Formerly it was the practice to use unequally divided racks for controlling the movements of the cone belt, thus providing a "let-off" motion, which allowed the intermittent movements of the cone belt to be comparatively much greater at the commencement of a set of bobbins than at the finish. With unequally divided racks it was possible to have uniform cone drums, but it has now been for a great many years the practice to equally divide the racks, and to have equal movements of the cone belt at each change of the lift all through the building of the bobbins. To meet the requirements of winding-on, it is now therefore the almost universal practice to make the cone drums with hyperbolical curves, the upper cone being concave in outline, while the lower cone is of a convex shape. The real reason for this peculiar configuration of the cones is because the addition of any given diameter of roving or cotton has a much greater proportional effect on the diameter of an empty bobbin than on a nearly full bobbin, and the winding-on revolutions of the bobbins—as controlled by the equal movements of the cone belt—must therefore be varied at the commencement of a set of bobbins more quickly than at the termination. Twice the diameter of bobbin requires half the *winding-on speed* (or excess speed of bobbin), four times the diameter requires one-fourth the winding-on revolutions, etc. A curve plotted out according to this proportion would at once be seen to be a hyperbola. In bobbin leading frames the bobbin makes a variable number of revolutions more than the spindle or flyer. As the

diameter of bobbin increases the excess revolutions must be diminished. This diminution of the excess revolutions must be the reciprocal of the increase in diameter as above indicated. It is well understood that the curve which represents an increase in diameter combined with a reciprocal decrease in speed is termed the "hyperbola". And the variations in the *winding revolutions* of the bobbins must agree with such a curve.

Q. What draft will there be in the slubbing, intermediate, jack and mule if the drawframe sliver be 60 grains per yard, $\frac{5}{8}$-hank at slubbing, $1\frac{3}{4}$ intermediate, $4\frac{3}{4}$ at jack, and spinning 32's twist at the mule?

A. The principal rule involved is as follows: The counts delivered by a machine divided by the counts fed to it will give the draft when no doubling is done. If doubling is done, then the answer must be multiplied by the number of doublings. In this case we have first of all to find the counts of the drawframe sliver, and the rule for finding counts at all machines is as follows:—

Divide the constant 8·33 by the weight in grains, and multiply by the number of yards taken.

(1) $\dfrac{8{\cdot}33 \times 1}{60} = {\cdot}138$ counts of sliver;

(2) ${\cdot}625 \div {\cdot}138 = 4{\cdot}52$ slubber draft;

(3) $\dfrac{1{\cdot}75 \times 2}{{\cdot}625} = 5{\cdot}6$ draft at intermediate;

(4) $\dfrac{4{\cdot}75 \times 2}{1{\cdot}75} = 5{\cdot}42$ draft at jack;

(5) $32 \div 4{\cdot}75 = 6{\cdot}73$ mule draft.

Note.—$\frac{5}{8}$ is reduced to ·625, and single roving is assumed at the mule and slubber, with double roving at the other machines.

Q. A slubber is making ·857 hank roving, with 20 strike wheel. What strike wheel will be required for $1\frac{1}{4}$ hank roving?

A. The strike wheel is a driving wheel, and is made smaller for finer counts in order to slower the lift. It varies inversely with the square root of the counts:—

$$\frac{\sqrt{{\cdot}857} \times 20}{\sqrt{1{\cdot}25}} = 16\tfrac{1}{2}.$$

Q. While doffing a roving frame what changes are made by the tenter in turning several times the wheel or handle below the frame? Explain the effect if neglected, and the frame restarted after doffing.

A. *Changes.*—(1) The cone belt is wound to its initial position at the thick end of the top or driving cone, and the thin end of the bottom driven cone drum. (2) Naturally at the same time the long rack which connects the change motion to the belt is returned to its initial position, and the weight which moves the long rack and the cone belt is lifted from its lowest to its highest position. (3) The "poker bar," or "hanger-bar," or "short rack" is wound to have its maximum length out of the change motion and towards the double slide.

Results.—If the cone belt were not returned to its initial position the ends would run slack, because of an insufficient amount of "winding on" motion being given to the bobbins. At the same time the coils of roving would be too close to each other owing to the lifter rail moving too slowly. If the short rack were not returned to its initial position the lifter rail would change much too soon, and the cotton would only cover perhaps two-thirds of the empty bobbins.

Q. Just before doffing a roving frame, is the cone strap nearer the large or small end of the bottom cone drum? and is the stud (in the slide) to which the hanger-bar is fixed, nearer to or farther from the box of tricks than at other times during the formation of the bobbin?

A. In all cases the cone strap is nearer to the large diameter of the bottom cone drum just before doffing. At the same moment the stud in the double slide is always nearest the box of tricks.

Q. When 5 hank rovings are made with 32 pinion and 56 back roller wheel, and a change is made to 40 pinion and 49 back roller wheel, what twist wheel will be required for the new hank if the 5 hank required a 20? What is the position of and work done by the twist wheel?

A. (1) The hank is made proportionally coarser both by making the change pinion larger and the back wheel lower.

$$\frac{32 \times 49 \times 5}{40 \times 56} = 3{\cdot}5 \text{ hank after the change.}$$

(2) A larger twist wheel is required always for coarser counts.

$$\frac{\sqrt{5} \times 20}{\sqrt{3 \cdot 5}} = 24 \text{ twist wheel required.}$$

(3) The twist wheel is almost invariably placed at the inside extremity of the main shaft of the frame. It is a driving wheel, and gives motion—through the medium of the top cone shaft—to practically all parts of the frame except the spindles and the positive half of the differential motion, and therefore the corresponding proportion of the bobbin speed.

Q. A jack frame turns off 33 hanks per week of 11 hank roving. What weight will two frames of 192 spindles each produce in a week?

A.
$$\frac{33 \times 192 \times 2}{11} = 1{,}152 \text{ lb.}$$

Q. 1900. What is the use of a traverse motion in a roving frame? Describe the construction of any form with which you are acquainted, and detail the defects arising from the irregular action of the motion.

A. It would have been better if it had been specified as the roller traverse or the bobbin traverse, as some students are apt to confuse the two. The author takes the roller traverse to be what is meant. At the actual examination some students took it one way and some the other.

The use of a roller traverse is to give a slow lateral motion to the rovings, so that they shall not channel the leather rollers by continual action on exactly the same portion of leather.

It is usual to compound some form of eccentric or cam with a worm wheel driven by a worm on the end of the back roller, so as to secure a very slow traverse.

The eccentric is made to push the guide-bar of the rovings a short distance laterally, and after the full part of the cam has been reached a spiral spring compels the guide-bar to follow the cam on the thin part. In a recent device the two rovings on the same leather roller are carried by different bars, which cause both rovings to be near the centre of the roller at the same moment, thus giving equal weight on them. Variable traverse motions have received a fair amount of adoption during recent years, and in connection with Fig. 44, a

little farther on, a full description of one of these motions is given.

Irregular action of the traverse motion causes channelling of the leathers by allowing the rovings to stop too long in one position. Sometimes a hesitancy is developed in these motions at the change, which causes the rovings to run off the edges of the rollers.[1]

Q. 1 00. In a roving frame all the various parts are driven from the jack shaft. What would be the result of changing the twist wheel for a larger one if no other changes were made? Reasons must be briefly given for each part of the answer.

A. The twist wheel drives practically all parts of the frame excepting the spindles. If the twist wheel were made twice the size it would make the following principal parts go double speed: Rollers, lifter rail and winding revolutions of bobbins (not total revolutions). The spindles would keep at the same speed as before, since they are driven quite independently of the twist wheel. The twist wheel drives the top cone shaft positively, and the latter drives the rollers positively, and as the twist wheel is a driver wheel the above statement will be evidently true as regards the rollers. The top cone drives the bottom one, and the latter drives both the sun wheel and the lifter rail. Although the sun wheel exercises an important influence on the driving of the bobbins, it only gives, say, 50 revolutions to the bobbins out of a total of 1,050 when the spindles make 1,000 revolutions per minute. In this case, therefore, the 50 revolutions would become 100, and the total bobbin revolutions would become 1,100.

The Gearing of Fly Frames.

Figs. 42 and 43 are gearing plans of fly frames as made by Messrs. Hetherington. The connections of the twist wheel can be readily traced. In practically all fly frames this wheel is fixed on the inside extremity of the pulley shaft, as shown here. In Figs. 42 and 43 actual working sizes of the wheels are given, and these illustrations are almost self-explanatory. It will be noticed that many wheels are the same size for the intermediate, as for the roving frame, while others are different in size.

[1] See also article and sketches further on in this chapter.

GEARING OF INTERMEDIATE FRAME.

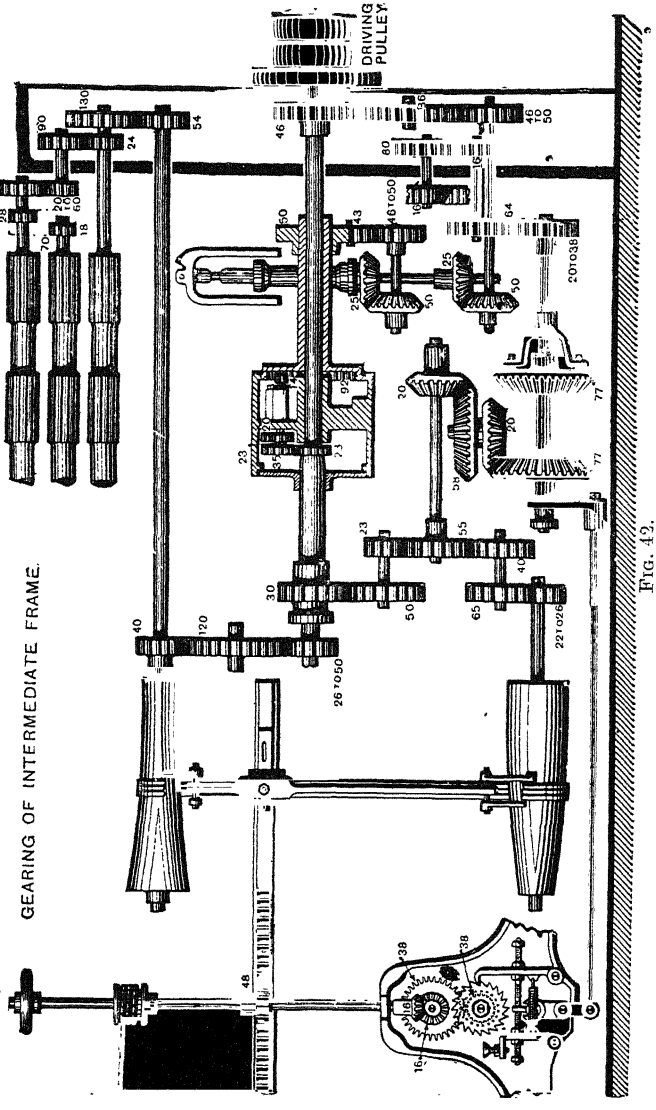


Fig. 42.

GEARING OF ROVING FRAME.

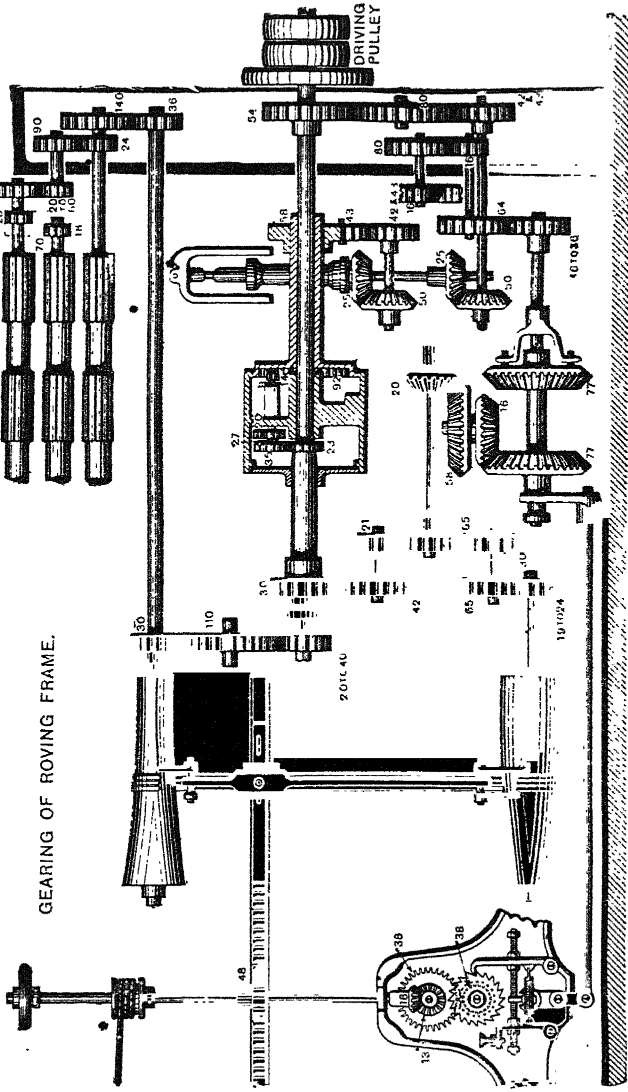


FIG. 43.

Q. 1901. In a roving frame the twist wheel has 30 teeth, and drives by a carrier the middle cone wheel with 40 teeth. The end cone wheel has 48 teeth, and gears with front roller wheel with 130 teeth. The front roller is $1\frac{1}{8}$ inches diameter. The spindle driving wheel has 40 teeth, and drives by carrier the spindle shaft wheel with 40 teeth. The spindle is driven by a spindle shaft skew with 55 teeth, gearing with spindle wheel with 30 teeth. Find the turns per inch.

A. Method I. :—

$$\frac{1 \times 30 \times 48 \times 9 \times 22}{40 \times 130 \times 8 \times 7}$$

·979 inches of roving delivered to one revolution of pulley shaft.

$$\frac{1 \times 40 \times 55}{40 \times 30} =$$

$1{\cdot}8\dot{3}$ revolutions of spindle to one of pulley shaft; then—

$$\frac{1{\cdot}83333}{{\cdot}979} = 1{\cdot}87 \text{ twists per inch.}$$

Method II. :—

$$\frac{40 \times 55 \times 40 \times 130 \times 8 \times 7}{40 \times 30 \times 30 \times 48 \times 9 \times 22} =$$

1·872 twists per inch as before.

Q. 1896. An 8-hank roving is produced by the use of a 35 change pinion. What hank roving would be obtained if a 42 pinion was substituted?

A. A rule often given for these changes of counts on any of the machines is: "Multiply the present counts by the wheel on and divide by the wheel to be put on". Perhaps it is more satisfactory to reason out as follows: Will a larger change pinion make the counts lower or higher? Of course nearly every worker knows that it will make the counts thicker or lower; therefore multiply the 8-hank by 35 and divide by 42:—

$$\begin{array}{r} 35 \\ 8 \\ \hline 42)280(6{\cdot}6 \\ 252 \\ \hline 280 \\ 252 \end{array}$$

Q. 1898. Suppose you began with a drawn sliver ·158 hank, and produced a slubbing 1·5 hank; two ends of slubbing put through the intermediate frame give a 3·5 hank, and two ends of intermediate through the roving frame give a 9-hank roving; what are the drafts in the slubbing, intermediate and roving frames respectively?

A.

$$(a)\ \frac{1{\cdot}50000}{{\cdot}158} = 9{\cdot}493 \text{ slubbing draft.}$$

$$(b)\ \frac{3{\cdot}5 \times 2}{1{\cdot}5} = 4{\cdot}6 \text{ inter draft.}$$

$$(c)\ \frac{9 \times 2}{3{\cdot}5} = 5{\cdot}142 \text{ draft of rover.}$$

Note.—It will be noticed that an unreasonably large draft is given by the slubber. This is due to two causes: (1) the hank sliver is much too coarse; it should be about ·18 or ·19; (2) $1\frac{1}{2}$ hank slubbing is much too fine for 9-hank roving; it should be about 1.

Q. 1900. Why is the square root of the quotient required in making calculations for the twist, rack, lifter and star wheels in roving frames? Illustrate your answer by the following example: You are making a 5-hank, the twist wheel being 28, and want to make a 7-hank. What twist wheel will you require?

A. We use square root in the above calculations because these wheels are all ruled in size by the diameter of the roving, and any calculation in which the diameter of the roving or thread is the ruling factor, as distinguished from its area, requires square root to be used in its working.

Taking particularly the case of the twist wheel, the diameters of the rovings vary approximately inversely as the square roots of the counts. The twist per inch for different counts varies directly as the square root of the counts, but a smaller twist wheel gives more twist, so that we get the following rule :—

Ascertain the square root of both counts; multiply the wheel on by the square root of the present counts, and divide by the square root of counts required.

```
     5·0000(2·23            7·0000(2·64
     4                      4
    ----                   ----
  42)100                 46)300
      84                     270
     ----                   -----
 443)1600               524)2400
     1329                   2096
     ----                   ----
      271                    ·304
              2·23
                28
              ----
              1784
              446
              ----
        2·64)62·44(23·65
             528
             ----
             ·964
              792
             ----
             1720
             1584
             -----
              ·1360
               1320
```

An alternative rule is as follows: Square the wheel on; multiply this square by the present counts and divide by the counts required. Ascertain the square root of the quotient.

ROLLER TRAVERSE MOTIONS.

Defects.

Everyone interested well knows that it is necessary in our frames and mules to impart a short, slow traverse to the rovings, so that they shall not channel the roller leathers by always working in the same position. Amongst practical men there has always been a feeling that these motions were more or less unsatisfactory, and various improved traverse motions have been from time to time placed upon the market, and have received more or less adoption. It is well understood that traverse motions should be set to move the rovings about on the leather surfaces of the top rollers as far as possible, *i.e.*, for roving to come as near to the ends of the leathers as is practicable. In the attempt to get this extent of traverse the rovings have been in scores and hundreds of cases run off the ends of the rollers into the necks and ends, to the serious discomfort of those in charge of the mules.

With old mules possessing defective traverse motions the present writer has experienced and witnessed very many little difficulties of this kind, especially when the machinery was cold and stiff after a stoppage. The consequence has been that such traverse motions have in some cases been made to give as little traverse as possible, and the roller leathers have rapidly developed channels or circumferential nicks. As a matter of fact, however, some of the old motions were absolutely incapable of a variation in the amount of traverse without a vast deal of trouble. The improved facilities for altering the extent of the traverse, and for causing this traverse to take place on a different portion of the roller—*i.e.*, more to the left or to the right as required—constitute, in the writer's opinion, one of the most genuine improvements in present traverse motions as compared with the older forms.

The Heart Cam.

Almost all possible shapes of simple cams and eccentrics that offered any probability of giving satisfactory working results were more or less in use half a century ago, including the well-known heart cam, so that it would be difficult to try anything new in this respect. In the light of this fact it is curious to see certain forms of simple cam or eccentric put

forward as being new and novel, and as likely to give better results than anything previously tried. The simple heart cam has proved very effective in years past, and the writer has seen it giving satisfaction on mules put up forty years ago. It gives a slow, uniform traverse, and a comparatively quick change at the ends, but it is the writer's experience and opinion that it is—like most other forms—somewhat defective in the latter respect.

Slackness in Tins.

As a matter of fact, there is always, and necessarily, a certain amount of space or slackness in the holes or slits of the guide tins, and when the change of traverse takes place the rovings do not answer to the reversal promptly, owing to this slackness. The guide tins themselves may reverse quite promptly, providing the changes are acute enough in the cams, and the springs and studs are in good condition, but the rovings cannot be got to change as promptly and rigidly as if they were made of iron. Diminishing the width of the slits used in the guide tins for single roving, or the size of small hole used in the guide tin for double roving, would be an improvement in this direction, but is scarcely permissible in most cases of actual practice. If attainable, it is probable that a good remedy for this running off of the rovings would be found in giving a positive jump or fall in the shape of the cam, so that the guide tins would have a sudden and absolute short movement at the moment of reversal. While it is easy to design a cam to give a sudden fall to a stud, it is not, however, very easy to give the stud a sudden lift.

Crank Motions.

In a limited number of cases the writer has come across practical men who have pinned their faith to the simple crank motion, which gives a much quicker motion in the middle of the traverse than at the extremities, and gives probably the least prompt reversal of any motion in use. With this motion the danger of rovings running off has been obviated by limiting the amount of traverse—a limitation decidedly objected to by many practical men. The non-uniformity of the traverse is also much disliked by many

practical men, so that crank motions appear to be only in comparatively moderate use. Great as the difficulty of running off has been found in fly frames, ring frames and mules, it has existed to a still more troublesome degree in the case of doubling winding frames, which wind the yarn into cheeses without using flanged bobbins. In this case it is not possible to limit the amount of traverse, so as to keep the cotton from the ends of the cheese.

Variable Traverse Motion.

Messrs. Brooks & Doxey make the following motion invented by Messrs. Cook & Harrison. With a view to preventing unequal wear of leather on the top rollers of preparing and spinning frames, and securing consequent advantages, variable traverse motions have within recent years been introduced. Through defects in the principle of a number of existing traverse motions, the advantages derived from their use have not been so great as anticipated or claimed. The following is a description of a good example of a variable motion. The several sketches are grouped under Fig. 44 and are also separately numbered and referred to.

There are five views shown, *viz.*, front, back and two sections, and also a facsimile of full-sized diagram produced by the motion. The same letters and figures apply in each case. Mounted upon a stud, 4, fixed to the bracket on roller beam are two wheels, H and I, varying in their number of teeth either by one or any other desirable number. On each of these wheels is fixed an eccentric, and on each of the eccentrics works a rod or link, E and F; these two rods or links are connected to a common bracket, G, one link being secured to the bracket at the bottom, and the other link at any convenient distance from the bottom. The points of attachment are shown at 2 and 3. The opposite end of the bracket, G, is attached to the ordinary traverse rod by means of the stud, 1, the stud passing through a hole in the traverse rod or through a bracket, J, fixed to the traverse rod. The stud, 1, can be moved up or down the vertical slot, so as to give a longer or shorter extreme traverse. The wheels, H and I, are driven by a worm cut in the roller or fixed to any convenient part of the machine. As this worm drives both the wheels, H and I, and one wheel having more teeth

than the other, one eccentric is continually varying its position in relation to the other, so that at one time the eccentrics will be moving both the links E and F, and with them the bracket, G, in the same direction, and at another time one eccentric will be throwing its link in one direction, and the

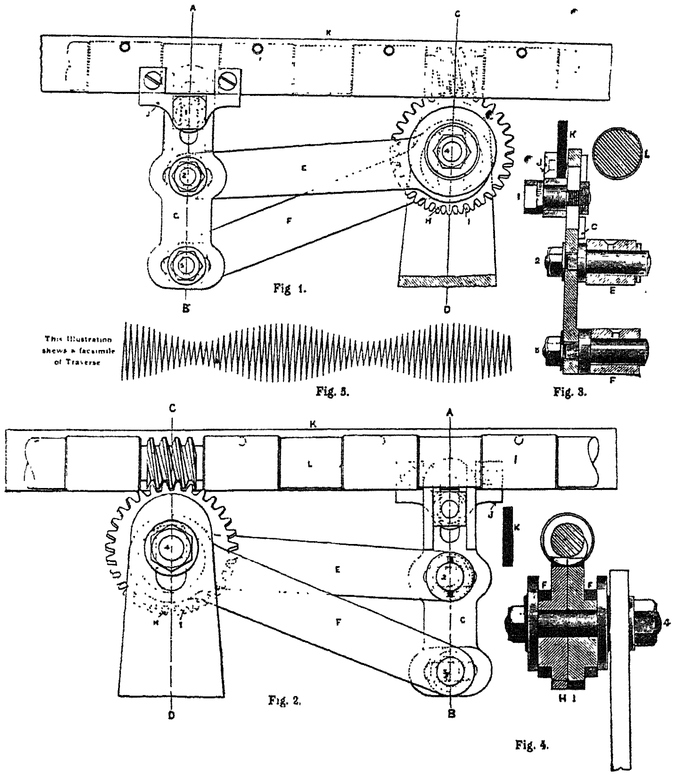


FIG. 44.

other eccentric its link in the opposite direction, thus giving a constantly varying length of traverse, as shown in Fig. 44. Supposing the motion were made so as to give an extreme traverse of 1 inch, the least traverse would be $\frac{3}{8}$ inch, and assuming the two wheels to have thirty and thirty-one teeth

respectively, the bottom back fluted roller would require to make 900 revolutions before the traverse changes from $\frac{3}{8}$ inch to 1 inch and back again to $\frac{3}{8}$ inch, which is shown as follows: When the back bottom roller has made 15 revolutions the thirty-teeth wheel has gone half round and completed the traverse in one direction, and consequently when this wheel has completed its circumference, and the roller thus made 30 revolutions, the backward and forward traverse is complete. As the thirty-teeth wheel necessarily gains upon the thirty-one teeth one tooth each revolution, it follows that the former must make 30 revolutions before both wheels come to the same relative position, so that it takes, as named above, 900 revolutions of the back bottom roller before the traverse changes from $\frac{3}{8}$ to 1 inch and back to $\frac{3}{8}$ inch. Consequently, if the draft is 6, the front roller must make 5,400 revolutions before the yarn comes to the same point of the leather again; or, in other words, the yarn, instead of coming to a given point every 30 revolutions of the back bottom roller, as with an ordinary traverse motion, it does so with this patent motion only every 900 revolutions. In addition to this advantage it will be seen that, by reason of the eccentrics varying their relative positions, the links are both on the dead centre, *i.e.*, at rest only once in every 450 revolutions of the back bottom roller, thus practically ensuring a continuous movement. The method adopted of attaching the apparatus prevents the possibility of the traverse rod lifting. There are no springs used in any way, and consequently the disadvantage inevitably arising ultimately from the latter, by reason of the same growing weaker with use, is obviated.

The following are the advantages *claimed* for this motion by the makers :—

1. A varying traverse upon the surface of the roller. (See diagram, Fig. 5.)
2. A considerable saving in leather and other material, as the rollers last much longer.
3. An improvement in the quality of yarn produced.
4. No dwell at the end of the traverse.
5. A perfectly steady movement without any lifting of the traverse rod.
6. There are few wearing parts.
7. Simple and easily altered throw.

The method of fixing the traverse motion is as follows:

Place the traverse guide in centre of the boss of fluted roller and fix the studs, 2 and 3, in centre of slots, then place the eccentrics at bottom. Next put the wheels in gear with the worm, and screw the small bracket, J, on traverse rod. If it should happen that the bracket has not been fixed correctly in centre of boss, unscrew studs, 2 or 3, and move traverse rod in the required direction. If the traverse be found to be too long, unscrew stud, 1, and raise the bracket, G; if too short, the bracket should be lowered. By this means the traverse can be regulated to the exact throw desired.

It must be clearly understood that many practical cotton spinners do not think it worth while to apply any make of the variable or compound traverse motions, while others have attached sufficient value to them as to give repeat orders.

Q. 1909. What are the objects of using bobbin and fly frames? Why is it necessary to insert twist in the roving during these processes, and what particular circumstances would you take into consideration in determining the amount to be used? How many passages of frames would you use for coarse, medium, and fine counts respectively, and why?

A. It might be said that bobbin and fly frames exist in order to draft out the cotton slivers until they are thin enough for the mule or ring frame, and at the same time to keep the cotton of sufficient strength, and to dispose in suitable form upon bobbins. It is necessary to definitely twist the cotton at this stage, because it has become too thin to withstand the necessary operations unless twist is put in, and the usual practical rule at the fly frame is to put in just as much twist as may be found necessary for this purpose. Breakage of bobbins at next machine is often an indication that more twist is required, but there are standard calculation rules which permit anyone to get somewhere near the required twist per inch. Recently a well-known Cotton Labour leader remarked to the writer that the most practised rule for roving frame twist was for the management to keep taking out twist until the minders grumbled about bobbins breaking. For coarse counts two passages of fly frame should be sufficient; for medium counts three passages are generally adopted, while for fine counts also three only are sometimes taken, although the writer is of opinion that four would be better, and this is often done.

Q. 1909. Describe the general arrangement of the cap bars on a roving frame, showing how the top rollers are adjusted and supported in position. How are the top rollers weighted for coarse and medium to fine hank rovings respectively? State how the different systems of weighting affect the setting of the rollers. 24 marks.

Part I. A very common and modern method of arranging the cap nebs for roving frame top rollers is to fix suitable pillars to the roller stands behind the rollers and setscrew to each pillar a long horizontal finger which reaches to the front of the rollers. These fingers usually contain several sides and three nebs are adjustably setscrewed to each finger—one neb each for back, middle, and front top rollers. By this arrangement the top rollers are held in position, and can be opened or closed very readily just as desired.

Part II. Lever weighting of top rollers on fly frames is seldom practised, the usual systems being combined dead weighting and self-weighting. Dead weighting is almost universal for the front top line of rollers, and is often used for the other two lines, especially in coarse counts, since it gives a more positive grip on the cotton fibres. For fine counts, however, self-weighting is very common for back and middle, the back top roller being made of extra heavy weight and large diameter to permit this self-weighting. The middle top roller, however, is only of small diameter, even with self-weighting, and in this way closer setting of front and middle top rollers is permissible with little or no damage to the fibre, even when setting inside the staple. With dead weighting of middle top roller we must always set beyond the length of fibre. Self-weighting of middle top rollers for slubbers or intermediates often proves too light to draft out tenter's piecings.

The Rollers: Cap-bars.

A serviceable and much favoured arrangement is shown in Fig. 45 as made by Tweedales & Smalley.

The iron flat clearers over the rollers in this case are held in position by hinges, which, being forked, slip over the cap-bar shaft and rest upon the boss of the cap-bar stand bracket,

thus permitting easy replacement of a broken hinge without having to take out the cap-bars.

During recent years increased care has been taken in the method of holding the cap-nebs for the top rollers in position. In this case the bracket which is pinned to the cap bar has a V-shaped groove cut at the bottom of a hole in which one angle of a 5-sided piece of steel is held by a setscrew. Upon this piece of steel are fixed in the positions desired the nebs or bearings for the front, middle and back top rollers. As these nebs also have a V-shaped hole, the act of tightening them up always brings them level on the top, and consequently vertical on the sides.

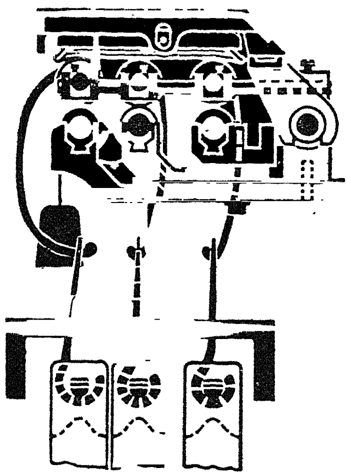


Fig. 45.

The roller stands and slides are milled out to receive the brass-bearings for all three rows of fluted rollers, and afterwards these brasses, which have been milled to match the dove-tail in the stands, are driven into position.

Other details may be noted in the illustration, Fig. 45, such as the strong channel section of the roller beam, the method of weighting the top rollers when all three lines are dead weighted by separate hooks, wires, weights and the setscrews for adjusting the bottom rollers.

Q. 1913. Fully describe the differences in the creeling arrangements, hank of creel rovings, and methods of working generally, on fly frames using single and double rovings respectively. State what qualities of cotton and counts of yarn are usually produced under these systems, stating the special advantages of each for the purposes specified.

A. By far the most of our roving frames use double roving, that is two back bobbins for one produced bobbin. This is

true of American cotton as well as of Egyptian, but there are some people on Egyptian cotton, and still a larger number on the American cotton, who prefer the single roving method. Assuming now cases of 4-hank rovings to be produced on the roving frame, some of the frames doing this from single and others from double back bobbins. Obviously for the double rovings we shall require practically double the creeling capacity—say, four rows of creel bobbins, as against only two rows for the single roving if the same creel pitch is used, or three rows if very open creels with wide pitch are preferred. For the double roving the creel bobbins must be twice the hank required for the single roving if the same roller draft is used, and even if the roller draft be somewhat larger for

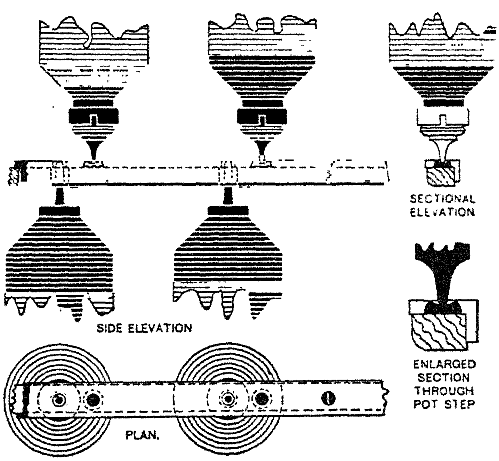


FIG. 46.

the double roving, yet still a much finer back bobbin will be wanted, and will be much more expensive to produce, requiring more intermediate frames. Single roving for the sake of cheapness and simplicity may be used for moderate qualities below the counts just quoted, while for the finer qualities the double roving is preferred, because it gives a better roving and a better yarn. As made by a well-known firm an excellent method of supporting the skewers in the creels is shown in Fig. 46. The bobbins in the creels are carried on

porcelain steps held in position by wood linings securely fastened to the angle irons.

Q. 1911. Explain the duties of the following portions of the mechanism of a speed frame: (*a*) The differential motion; (*b*) the cone drums. State fully how each of these portions of the mechanism, as distinct from the other, affects the winding action.

A. The differential motion on a speed frame is essentially a mechanism which permits a frequently varying rate of speed to run through it to the bobbins. It does not create this difference of speed, but permits the speed variation resulting from the lateral movement of the cone belt to conveniently pass along to the bobbins. Usually a differential motion—and there are several makes of this motion—is composed of two distinct portions, one of which is driven directly from the main shaft, and remains constant, while the other is driven indirectly by means of the cone drums, and responds most accurately to the fine variations in speed coming from the cone belt and lower cone drum. The resultant or driven wheel of the motion represents the net effect of the fixed and variable drives, and the variable usually helps on the constant speed, but will just as readily act as a speed reducer when required in flyer lead frames. Referring now to the cone drums, it is the custom to make the top cone concave and the lower one convex in order to obtain the exact speed variation required, in this way making up for the use of a uniform let-off motion. In all cases the belt is on the largest diameter of the top cone and smallest diameter of bottom cone for empty bobbins, and is then moved gradually to the opposite ends as the bobbins increase in diameter. In this way the speed of the variable portion of differential motion is gradually roduced.

Q. 1913. From the following particulars of a fly frame find the correct size of the pinion wheel for driving the sun wheel of the Holdsworth differential motion, assuming the frame works bobbin leading. The twist wheel of 35 teeth drives the middle top cone drum wheel of 40 teeth, and the diameters of the large and small ends of the cone drums are 6 inches and 3 inches respectively. The pinion on the bottom cone drum shaft has 16 teeth, and drives a wheel of 66 teeth on

the jack shaft, on the end of which is the pinion driving the sun wheel of 112 teeth. The bobbin wheel in the differential motion has 40 teeth, and drives a wheel of 41 teeth on the end of the long bobbin shafts, on which are the skew gear wheels of 50 teeth driving the bobbin wheels of 20 teeth. The driving shaft runs at 286 revolutions per minute, the spindles run at 700 revolutions per minute, the empty bobbins are $1\frac{1}{4}$ inches diameter, and the roving contains two turns per inch.

A. The spindles run at 700 revolutions per minute, and two spindle revolutions go towards putting the twist into one inch of roving, so that the number of inches per minute must be $700 \div 2 = 350$ inches.

The circumference of the empty bobbin must equal

$$\frac{5}{4} \times \frac{22}{7}$$

Which equals length wound upon one revolution of bobbin, so that 350 inches will equal

$$350 \div \left(\frac{5}{4} \times \frac{22}{7}\right)$$

$$= \frac{350 \times 4 \times 7}{5 \times 22} = 89{\cdot}09$$

= excess or winding-on revolutions of bobbin as obtained from the sun wheel and cone drums. We may now work back from excess bobbin revolutions through the differential motion to the cone drums, and thence to the driving shaft, although it makes a long calculation, and some might prefer to split it into sections. It must be remembered that two revolutions of the bobbin wheel or resultant wheel of the differential motion only represent one revolution of the sun wheel. Also that the jack shaft pinion is unknown, and so we place the 286 revolutions of driving shaft in the place of the jack pinion.

$$\frac{89{\cdot}09 \times 20 \times 41 \times 112 \times 66 \times 3\text{ in.} \times 40}{50 \times 40 \times 2 \times 286 \times 216 \times 6\text{ in.} \times 25}$$

Answer:

$$= 16{\cdot}97, \text{ or, say, a 17's pinion.}$$

Q. 1910. Describe a modern method of balancing the lifter rail of a bobbin and fly frame, and state its advantages. How would you expect a badly balanced rail to affect the build of the bobbin and the working of the frame generally? 24 marks.

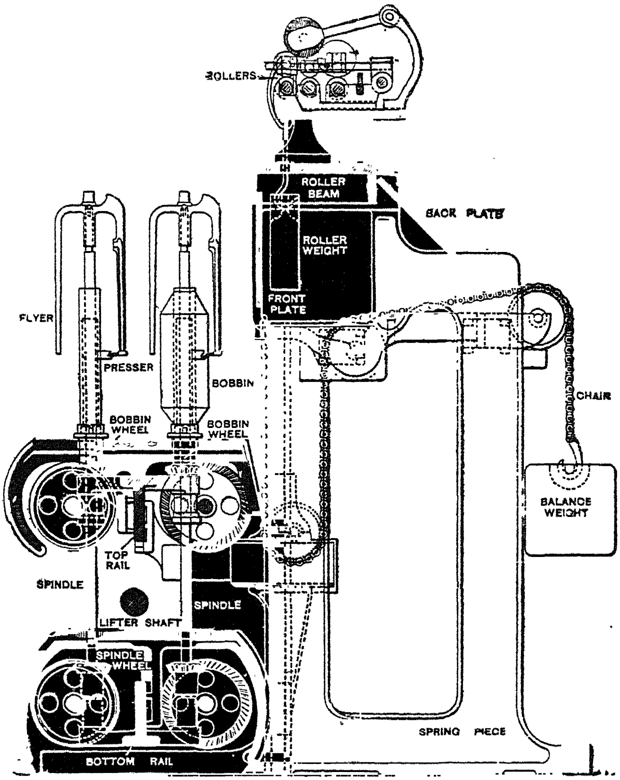


FIG. 46a.

Dead weighting is shown in Fig. 46a, with connection of chain from weight to top rail as made by a well-known firm. Note also the skew gear.

A. One arrangement or another of lever balancing of the

rail is now very generally adopted, although the dead weight system still is extensively in vogue In a well-known example a heavy weight is suspended by a chain from a block on a short shaft, so as to always be trying to turn the shaft. A second chain is suspended also from another block on short shaft, and is wrapped thereon in the opposite way, so that it tends to wind on the block as the other comes off, and *vice versa*. From the second chain is suspended a short lever, which supports the lifter at one end while its other end passes loosely through the framing. The number of weights and the leverages are arranged to balance the lifter to the required degree, and the rail is supported from the centre, which is an advantage. This particular arrangement is simple, cheap, and not much liable to disarrangement, and is more or less made by several firms. A badly balanced or binding rail is by no means an uncommon fault, and in the first place it reacts on the cone belt by binding in the slides or against the collars. Both cone belt and main belt may have extra work imposed on them, with the result that bobbins run off at the ends will occur, and rough or ridgy spacings.

The arrangement just described may now be readily understood from the illustration, Fig. 47. See also the alternative arrangement already described in this chapter, with Fig. 33.

Q. 1911. Describe the manner in which the spindles of a speed frame are supported from the spring pieces, and fully describe the construction of the spindle foot and footstep bearing indicating the means used to counteract frictional effects.

A. Each spindle of a fly frame is supported by a rigid footstep bearing, and also by a moveable bolster bearing or collar. The bolster bearing may be either a "short collar" or a "long collar," the latter supporting the spindle over a considerable length, and very high up. The collars are carried by the top rail, which is balanced by weights, and is sustained by vertical racks and by strong slide-brackets, which latter move up and down in vertical slides in the spring pieces. The footsteps are formed in the bottom rail fixed in position at the bottom of the spring pieces and recessed to provide easy bearings for the spindle feet. Each spindle foot is rounded off to a point at the bottom, and next higher up is a reduced diameter of spindle, thus giving a kind

of flange where the thicker and chief portion of spindle starts. From this point upwards to above spindle bevel each spindle is often recessed to permit convenient oiling, and the footstep bearing is constructed to retain a nice quantity of lubricant. Proper lining up of spindles and bearings, rounding of spindle feet, efficient oiling, good balancing of lifter, and keeping things clean, are all designed to reduce friction, but there is more need for improvement in this respect in the bolsters than the footsteps.

Q. 1913. Describe the various functions performed by the spring pieces of a fly frame, and indicating the special features of their construction which are necessitated by the duties required from them.

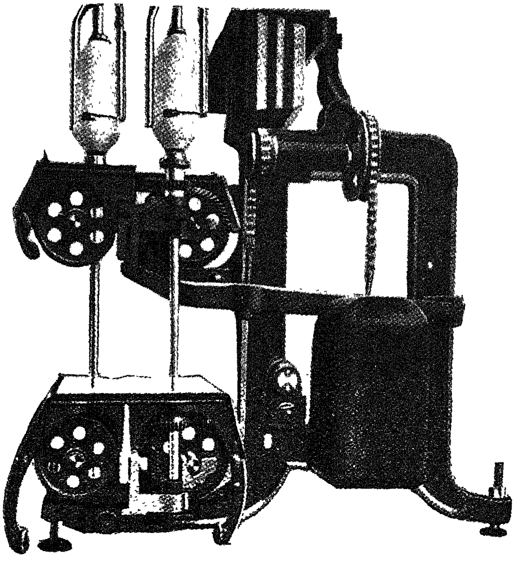


FIG. 47.

A. Combined with the two frame ends, the spring pieces practically support the whole of the fly frame. First and foremost we have the roller beam extending from one frame end to the other and resting upon the top of every spring piece so as at once to form a rigid framework capable of

answering all requirements in regard to strength and steadiness. Proceeding to the other extreme of the frame down to the feet of the spring pieces or samsons, we have forwardly-projecting feet upon which is fixed the bottom rail or spindle rail of the frame, and this rail, like the roller beam at the top, helps to bind the length of the frame together, while at the same time serving its purpose of providing a footstep for each of the spindles. At the back of the machine projecting fingers extend from the spring pieces for the purpose of holding the vertical creel rods, which in their turn support all the lengths and rows of iron or wood creels for the bobbins. The spring pieces support a large amount of the gearing of the machine, either indirectly through the roller beam, or else directly. For example, one cross rail from the spring pieces supports the change motion, and another cross rail helps to support the differential winding motion. The cone drums depend partially upon the spring pieces for their support. Last but not least we have the top rail or lifter rail, which is partly sustained by the weights and chains and vertical slides in the spring pieces, and partly by the vertical racks and long lifter shaft.

A spring piece is shown very clearly in the illustration, as made by a well-known firm (Fig. 48). The foot-adjusting screws, the method of supporting the spindle or lower rail, and the method of supporting and balancing the top or lifter rail may all be followed in this and the previous illustration.

Q. 1910. Describe the construction of the bottom rollers of a roving frame, and explain, with sketches, the method of coupling them together. Why are these rollers fluted, and upon what principle should the fluting be arranged to give the best results?

A. The bottom rollers are made in short lengths of mild steel, which may afterwards be optionally case-hardened. Each ordinary bottom roller contains four separate features, *viz.*, the finely fluted working bosses, the bearing point for revolving in the stand, one end made of a square spigot shape, and the other end with a square socket. The spigot end of one roller is fitted into the socket end of the next roller, so as to form a spigot joint, and in this way practically one line of rollers is formed the length of the frame. This method is convenient for occasional pulling to pieces for

transit, cleaning, repairs, or other purposes. The fine flutes grip the cotton firmly against the softer leather surface of the top roller, and give more uniform drafting than would smooth rollers. It is the more usual practice to cut the flutes round the roller with a slightly eccentric pitch so that the constant action of the flutes on the leathers of the top rollers does not become too much repeated on the same exact points of the leather, and the latter do not readily become indented or fluted like the iron rollers.

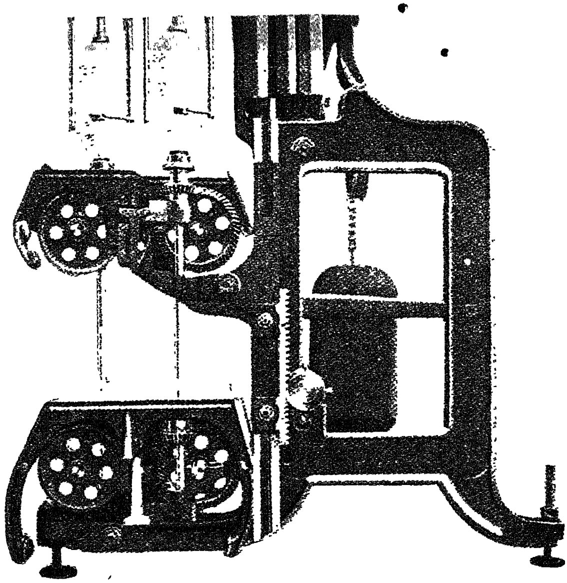


FIG. 48.

Q. 1910. Sketch and describe the full bobbin stop motion of a roving frame, and state briefly how it is adjusted to maintain a definite length of roving in each sett produced. What evil effects would irregular sizes of bobbins produce in practice?

A. There are various forms of full bobbin stop motions for fly frames, some motions being operated in an entirely different manner from others. Motions operated from the

front roller are often considered to give the most exact knocking-off, one set of bobbins after another. In a well-

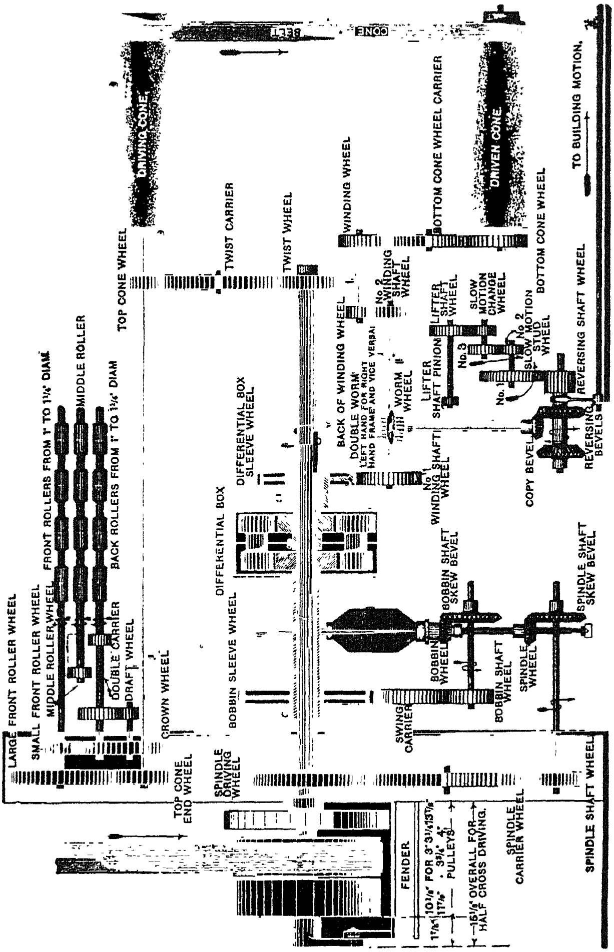


FIG. 48a.—Gearing plan of fly frame. Brooks & Doxey.

known example a single worm on front roller drives a worm wheel on stud. A second single worm on same stud drives a second worm wheel, and on same stud as this latter is

yet a third worm, which drives a third worm wheel. The short shaft of the third wheel carries a finger, which on completing a revolution raises and releases a latch lever attached to a weighted lever, which latter acts upon an adjustable collar fixed on the stop-rod, so as to place the belt on its loose pulley. Irregular sizes of bobbins quite upset the order and routine of creeling at the next process, because bobbins come empty at varying times, and no proper system of working the creels can be maintained. In extreme cases too many bobbins may require changing at one time, and a machine may have to be stopped a short time to get straight. Sometimes a number of the pieces of bobbins are changed before being finished, and must either be subsequently recreeled or else made into waste.

An excellent arrangement as made by Messrs. Brooks and Doxey is shown in Fig. 48.

This motion can readily be adjusted to knock off at any diameter of bobbin. After the frame has been knocked off by this motion it cannot be re-started without winding back the cone drum strap. At the proper time, the trigger lever is moved by the longitudinal sliding of the cone drum rack and unlatches the mechanism so that the strong spring shown promptly slides the belt upon the loose pulley through the medium of the knocking-off finger and the knocking-off rod.

Q. 1911. Describe the lifter mechanism of a speed frame for actuating the bobbin rail, and explain fully why it is necessary (*a*) to drive this motion from the cone drums, and (*b*) to provide a change place in the wheel train.

A. The bobbin rail or lifter rail of a fly frame is balanced either by dead weights or lever weighting to give an easy drive both up and down, and is secured to brackets which move up and down in vertical slides or grooves provided in the spring pieces. Also secured to the bobbin rail are vertical racks, each one gearing with a rack pinion fastened to the long lifter shaft. The lifter shaft is driven very slowly round by a long train of wheels—often a dozen wheels or so—reaching from the lifter shaft to the bottom cone drum, and for the most part consisting of small driving and large driven wheels to reduce the quick cone speed down to the very slow speed of lifter shaft. The reversing bevels may be interposed near the middle of this train of wheels and permit alternate

up and down direction of lifter just as one or the other of the bevels is in gear with the strike bevel. (*a*) It is necessary to drive this motion from the cone drums, because the bobbin rail speed must be reduced as the bobbins increase in diameter, just the same as the winding-on revolutions of bobbins are reduced. (*b*) It is necessary to provide

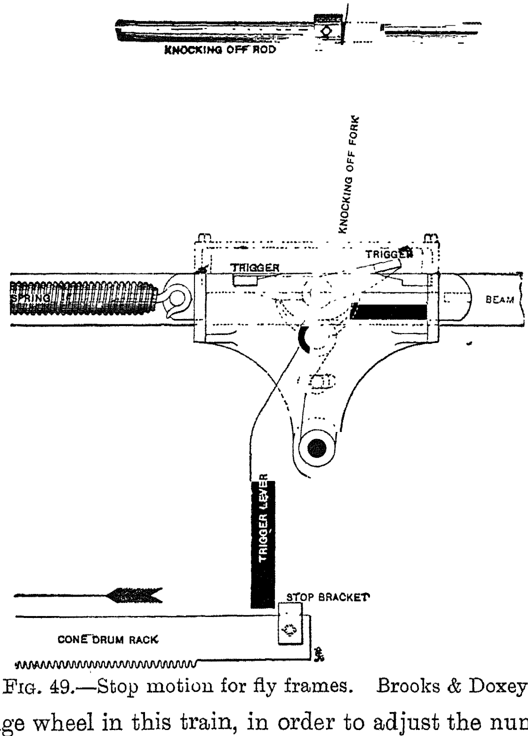


FIG. 49.—Stop motion for fly frames. Brooks & Doxey.

a change wheel in this train, in order to adjust the number of coils or rounds of roving per inch of lift to the best advantage. For example, suppose the coils were too close, and the winding correct, the lifter could be speeded by changing this wheel.

In Figs. 47 and 48 may be noticed the vertical slides, and the vertical rack for one spring piece. Also the arrangement of the skew bevels for spindle and bobbin rails.

Q. Explain the method of driving the pulley shaft of a fly frame from the line shaft or counter shaft.

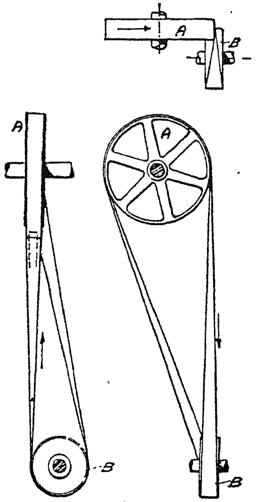


Fig. 50.

The half-crossed belt method as shown in Fig. 50, is very popular for driving fly frames, drawframes and combers, because the required speed is not very high, the horse power is only moderate, and there need not be much difference in diameter between top and bottom pulleys. Fig. 50 includes three views of the top and bottom pulleys AB. In some cases the gallows pulley drive is used for fly frames as explained in this treatise in connection with the ring frame. Often for roving frames the top and bottom pulleys are about equal in diameter.

Q. 1911. Describe, with sketches, how the bottom rollers of a speed frame are driven from the driving shaft, and state which rollers are affected by an alteration of twist wheel and change pinion respectively. Describe the manner in which the twist wheel controls the amount of twist inserted in the roving.

A. The more common method of driving is to start with the twist wheel at the inside extremity of the principal or pulley shaft of the frame, and by means of a single carrier to drive a wheel fixed near the middle of the long top cone-shaft. On the out end of this latter shaft is secured a wheel which gears into and drives a larger wheel fixed on the front bottom roller. The almost invariable method of driving the back and middle rollers is to drive directly from front to back by means of four well-known wheels termed respectively as follows: (1) The front roller pinion; (2) the crown wheel or large carrier; (3) the change pinion for draft; (4) the back roller wheel. Then a small pinion on back roller drives another one on the middle roller by means of a broad carrier. In the driving above described it will be noticed there are two

of the principal change wheels of the machine, *viz.*, the twist wheel and draft change pinion. If we put on a larger twist wheel all the rollers are equally speeded, and this reduces the amount of twist in the roving because the spindle speed remains unaltered. A larger change pinion quickens the back and middle rollers only.

All these wheels and connections may be readily followed in the gearing plans of fly frames previously given in this chapter. (See Fig. 48a; also Figs. 42, 43.)

Q. 1914. State to what extent the twist in rovings would differ in each of the following circumstances : (*a*) Different hank rovings made from the same class of cotton, and (*b*) the same hank roving made from different classes of cotton. Give full reasons for these differences in each instance.

A. 1914. (*a*) It is the rule to increase the twist per inch put into hank rovings as the counts become higher or finer from the same class of cotton. Example, some people obtain the twist per inch by multiplying the square root of the hank roving by the constant number 1·2 when using just a moderate class of American cotton. Following this rule, and taking the extreme examples of 4-hank and 9-hank rovings, the required twist per inch will be found as follows :—

$$\sqrt{4} \times 1{\cdot}2 = 2 \times 1{\cdot}2 = 2{\cdot}4 \text{ for 4-hank.}$$
$$\sqrt{9} \times 1{\cdot}2 = 3 \times 1{\cdot}2 = 3{\cdot}6 \text{ for 9-hank.}$$

(*b*) Experience has demonstrated that finer and longer-stapled cottons will work satisfactorily with a somewhat smaller amount of twist in the rovings than will poorer and shorter staples. There is no absolutely common and exact law or rule for roving twists, but average practice is represented somewhat by the following statements :—

For average American cotton, twist per inch $= \sqrt{\text{counts}} \times 1{\cdot}2$.

For average Egyptian cotton, twist per inch $= \sqrt{\text{counts}} \times 1{\cdot}0$.

Taking 9-hank roving in each case, the required twist per inch would be found as follows :—

$$\sqrt{9} = 3 \times 1{\cdot}2 = 3{\cdot}6 \text{ for American cotton.}$$
$$\sqrt{9} = 3 \times 1 = 3 \text{ for Egyptian cotton.}$$

Q. 1914. State what functions of a fly frame are controlled by the ratchet or star wheel of the change motion, briefly describing how the control is effected in each instance. What would be the effect of an increase or decrease in the number of teeth in this wheel?

A. The ratchet wheel of a fly frame does work which in some respects resembles the work of the ratchet wheel or shaper wheel of a mule, but in some other respects the work is quite dissimilar. On a mule or ring frame the ratchet wheel controls the diameter of the cops along with the thickness of the yarn, but on the fly frame the ratchet wheel does not control the diameter of the bobbins, although there is a relation between the two, as, for example, in both cases a larger wheel is used with a thinner hank or count of cotton.

Dealing now strictly with the fly frame, the chief duty of the ratchet or star wheel is to control the longitudinal traverse of the cone belt along the length of the cone drums. In this way the ratchet wheel regulates the speed of the bobbins both in regard to revolution and in regard to vertical reciprocating movement. As the bobbins increase in diameter it is necessary to diminish the speed of the bobbins in the two directions indicated, and this diminution must be done in a manner calculated to exactly agree with the increase in bobbin diameter, according to the counts and thickness of the cotton. To illustrate with a definite example we will assume a change from 10-hank to 6-hank roving. A smaller star wheel must be applied, or one with fewer teeth, and this will have a necessary effect, as follows: The longitudinal movement of the cone belt occurring at each reversal of the lifter, will now be greater than previously, and therefore the diminution in speed of rotation and in speed of vertical traverse will be proportionately greater for each change, as required by the more rapid increase in bobbin diameter due to making a thicker roving. A bobbin leading frame is referred to in this answer.

The size of ratchet wheel also controls the amount of each longitudinal traverse of the short rack, poker, or hanger-bar, and in this way is a chief factor in forming the two cones of the bobbins. For example, in the change from 10- to 6-hank roving the smaller ratchet wheel will give a greater movement each time as required by the thicker hank roving.

The more rapid shortening of the effective working length of the short rack results in the jack screws moving through their proper space in a proportionately shorter time, thus changing the lifter traverse sooner, and before the lifter can travel as far as previously. (See Figs. 42, 43.)

Q. 1914. Describe how the spindles of a fly frame are driven, commencing from the driving shaft. Give full details of the manner in which similar direction of rotation is imparted to both back and front rows of spindles from opposite direction of rotation of the two long spindle driving shafts.

A. The almost invariable method adopted for driving the spindles in slubbings, intermediates and roving frames, of whatever make, is to drive directly down from a spur wheel on the main pulley shaft, to a similar spur wheel on the first long spindle shaft through the medium of a large carrier wheel. The spur wheel on first long spindle shaft gears directly with and drives a similar wheel on second long spindle shaft, and this means that these two long shafts revolve in opposite directions. Skew bevels on the long spindle shafts drive smaller bevel wheels setscrewed on the spindles, there being a pair of bevels for each spindle. The spindles of both rows are made to revolve in the same direction by the simple expedient of placing the skew driving bevel on the right-hand side of its driven bevel in one row, and on the left-hand side for the other row. The skew gearing is needed because the long driving shafts for the spindles are placed either in front or else behind the rows of spindles. (See Fig. 48a.)

Q. 1910. Describe the action of the flyer on a roving frame during the building of a bobbin, and state fully its effect on the twisting and winding operations. Describe, with the aid of sketches, the method of connecting the presser finger to the hollow leg of the flyer, and state from what source it derives the force with which it presses on the bobbin.

A. The flyer is fitted more or less firmly on the top of the spindle in a manner permitting of ready removal for doffing or other purposes. The cotton is passed through the hole in top flyer, out at the small side aperture, and then down the inside of the leg, round the presser, and upon the bobbin.

The presser holds the cotton in definite relative position to the bobbin, and the bobbin usually revolves faster than the flyer, and in this way winding on is done by the cotton being drawn upon the bobbin. As regards twisting, the hollow flyer leg is out of centre with the spindle, and so also is the side aperture in flyer top, and therefore the cotton is taken round the spindle as a centre, and thus twist is inserted. A projection of one kind or another is formed on the upper portion of the hollow flyer leg, and the vertical wire of the presser is suspended from this projection while the lower extremity of the wire is made to loosely encircle the hollow leg. The vertical wire of the presser, and the presser or paddle itself virtually form the two arms of a lever fulcrumed on the hollow leg, and during rotation the vertical wire tends to fly outwards by centrifugal force, which means that the paddle is forced against the bobbin. The pull of the cotton also helps to increase the pressure. In connection with this answer and the next one, reference may be made to the illustrations for flyer and bobbin lead, showing the flyers, spindles, and pressers, given previously in this chapter in Fig. 32.

Q. 1913. Explain with the aid of sketches the method of threading the roving through the flyer of a fly frame, giving full reasons for the course followed at each stage of the operation. State what circumstances require slight variations in the method of threading, and describe how these are made.

A. It is the usual custom for the roving first to pass through a round aperture in the top of the flyer and come out by means of a smaller side aperture in the head of the flyer. It at once becomes the question as to whether the roving shall pass round the flyer top forwards in the direction of flyer rotation or backwards in the opposite direction. Experience has shown it to give a more solid looking roving when passed in the forward direction, and this is the common procedure. The cotton may pass either three-fourths round the flyer top, or only one-fourth, the former practice giving more strain on the roving and producing a harder bobbin, and being therefore adopted generally for counts of rovings made from ordinary American cotton, while for finer counts some prefer what is termed the "straight down" method. A slit in the hollow leg of the flyer facilitates the rapid threading of the roving from top to bottom, at which

latter point the cotton is now wrapped round the presser. For American cotton three times round is common practice, and is also often adopted for Egyptian up to 10 or 11 hank roving, as it gives a much harder bobbin than the twice-round method. The latter, however, imposes distinctly less strain on the roving, and is therefore often preferred for Egyptian cotton, especially in the finer counts. It is well known that a bobbin and fly frame will often tend to make a softer bobbin in the front row than in the back one, and to neutralise this undesirable effect some firms adopt the practice of three times round for the outer row and twice round for the inner row. As an alternative practice it is sometimes preferred to pass the cotton three-quarters round the flyer top for the outer row of bobbins and one-quarter round for the inner row. Sometimes the slits down the hollow-flyer leg are curved to prevent slack rovings from flying out. In the finest counts it is yet sometimes the practice not to use pressers, but to make soft bobbins by taking the roving directly from flyer-leg to the bobbin.

Q. 1913. Sketch the outlines of the top and bottom cone drums of a fly frame, indicating the position occupied by the cone belt at the commencement and finish of a set of bobbins. Describe the manner in which the outlines of these drums are developed, and how they control the winding tension of the roving at any diameter of the bobbin.

A. The cone belt in all bobbin and fly frames commences at the thick end of the top cone, and the small end of the bottom cone for a fresh set of bobbins. Every time the lifter traverse is reversed and a fresh layer of cotton begins to be placed on each bobbin, the cone belt is moved possibly $\frac{5}{16}$ inch or so along the length of the cone drums, so as to reduce the speed of the bobbins. The top cone drum is always concave or hollow in outline, while the bottom cone is always convex or rounded towards the middle of its length, so that neither one nor the other is of true conical outline. The cone drums help to drive the bobbins, more especially with regard to the excess revolutions of the bobbin over the spindle as required for the purposes of winding on. It follows that in the usual bobbin leading frame, the bobbins are driven round more and more slowly as the cone belt moves more and more towards the thin end of the upper

cone because the lateral movements of the cone belt bring it, so to speak, upon a smaller driving and a larger driven pulley. With reference now to the concave and convex outlines, it may be said that this gives a gradually reducing amount of speed variation for any given length of the cones, and this effect is required because each additional increase in bobbin diameter becomes of less proportional value as the bobbins become fuller. For example, an increase in diameter of $\frac{1}{16}$ inch is of much greater proportional value at the commencement of a set of bobbins, with a bobbin $1\frac{1}{8}$ inch or $1\frac{1}{4}$ inch diameter, than it is upon an almost full bobbin.

The full gearing plan of a fly frame in Fig. 40 illustrates the above features.

Action of Parts.

Q. 1911. The cone drum rack escapement of a fly frame is arranged as follows: The pitch of the cone drum rack is $\frac{1}{4}$ inch, and the rack which goes with it contains 30 teeth. This rack wheel is carried by a vertical shaft, on the lower end of which is a bevel wheel of 20, gearing with another bevel wheel of 32 teeth, fixed on the star wheel stud. The star wheel contains 24 teeth, and the cone belt traverses along 30 inches of the cones during the formation of the bobbin. Find (1) the number of layers contained by a full bobbin, and (2) the size of the star wheel which would be necessary to give correct movements to the cone drum rack if the 20's bevel on the upright shaft were replaced by a 32's bevel.

A. (1) The belt and cone rack move $30 \times 4 = 120$ quarter inches. Because the rack wheel contains 30 teeth $\times \frac{1}{4}$ inch pitch, we obtain :—

$120 \div 30 = 4$ revolutions of the vertical shaft.

and $$\frac{4 \times 20}{32} = 2\tfrac{1}{2} \text{ revolutions of the short shaft}$$

to which the star wheel is secured.

$24 \times 2\frac{1}{2} = 60$ teeth moved by the star wheel, or 120 half tooth escapements, representing 120 layers of rove plus 1 or portion of 1 put on before the rack wheel makes its first escape.

(2) We have on a 24 star wheel to begin with, but if we increased the bottom wheel from 20 to 32 this would reduce the proportionate movement of the cone drum rack at each reversal, unless counteracted by some equivalent alteration. We therefore may put on a rack wheel with fewer teeth, but of greater pitch, so that the rack would move as far as before at each change, but there would be fewer layers of cotton for four revolutions of star wheel shaft, although changing the 20 to 32 would affect this in the first calculation.

$$\frac{24 \times 20}{32} = 15\text{'s star wheel.}$$

In this question the alteration of the 20 to 32 naturally affects the net result, but in actual changing of counts this wheel would not be altered, and a smaller star wheel would be applied for a coarser hand so as to give fewer escapes of star wheel, but each escape giving a greater movement to the cone rack.

The following particulars are given by Messrs. Dobson and Barlow :—

PRODUCTIONS OF FLY FRAMES.

Slubbing Frames—Indian and Low American Cotton.

Speed of spindles=550 revs. per min.
Dia. of full bobbin = $5\frac{3}{4}$ in.
Weight of full bobbin = 30 oz.

Dia. of front roller = $1\frac{1}{8}$ in.
Lift = 10 in.
Time lost in doffing, etc. =14 min. per set.

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist Per Inch.	Hanks per Spindle per Day of 10 Hours.	Lb. per Spindle per Day of 10 Hours.	Hanks per Week of $56\frac{1}{2}$ Hours.	Percentage of Time Lost in Doffing, etc.
0·4	189	2·9	0·821	9·4	23 51	53·1	29·2
0·5	169	3·24	0·919	9·165	18·33	51·78	22·8
0·6	153	3·55	1·006	8·898	14·83	50·27	18·4
0·625	151	3·63	1·027	8·787	14·06	49·64	16·0
0·7	143	3·84	1·087	8·52	12·17	48·18	15·1
0·75	138	3·97	1·125	8·35	11·13	47·17	13·6
0·8	134	4·1	1·162	8·2	10·25	46·33	12·7

Slubbing Frames—American Cotton.

Speed of spindles = 550 revs. per min. | Dia. of front roller = $1\frac{1}{4}$ in.
Dia. of full bobbin = $5\frac{1}{2}$ in. | Lift = 10 in.
Weight of full bobbin = 28 oz. | Time lost in doffing, etc. = 14 min. per set

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist Per Inch.	Hanks per Spindle per Day of 10 Hours.	Lb. per Spindle per Day of 10 Hours.	Hanks per Week of 56 Hours.	Percentage of Time Lost in Doffing, etc.
0·625	177	3·10	0·79	10·66	17·06	60·23	22·7
0·75	161	3·40	0·866	10·29	13·72	58·13	17·9
0·8	157	3·5	0·894	10·176	12·72	57·49	16·7
0·875	150	3·67	0·935	9·9	11 32	55·93	15·2
0·9	147	3·72	0·948	9·886	10·94	55 82	13·6
1·0	140	3·92	1·000	9·52	9·52	53·78	12·6
1·1	133	4·11	1·048	9·24	8·4	52·20	10 8
1·125	131	4·18	1·066	9·11	8·1	51·47	10·6
1·2	128	4·3	1·095	8·97	7·48	50·68	10·0
1·25	125	4·39	1·118	8·84	7·07	49·94	9·1
1·3	123	4·47	1·14	8·71	6·7	49·21	8·5
1·4	118	4·64	1·183	8·5	6·07	48·[illegible]2	7·5
1·5	114	4·80	1·224	8·27	5·51	46·72	6·8
1·6	111	4·96	1·265	8·06	5·04	45·54	6·4
1·625	110	5·00	1·274	8·00	4·91	45·20	6·3
1·7	107	5·12	1·304	7·85	4·62	44·35	6·0
1·75	106	5·19	1·322	7·77	4·44	43·90	5·75
1·8	104	5·27	1·342	7·68	4·25	43·22	5·53
1·9	101	5·41	1·378	7·501	3·94	42·29	5·2
2·0	99	5·55	1·414	7·34	3·67	41·47	4·8

Slubbing Frames—Good Egyptian and Sea Islands Cotton.

Speed of spindles = 400 revs. per min. | Dia. of front roller = $1\frac{3}{8}$ in.
Dia. of full bobbin = $5\frac{1}{2}$ in. | Lift = 10 in.
Weight of full bobbin = 26 oz. | Time lost in doffing, etc. = 14 min. per set

0·7	158	2·52	0·585	10·6	15·14	59·9	21·7
0·75	150	2·61	0·606	10·47	13·96	59·15	19·6
0·875	141	2·82	0 654	10·12	11·56	57·17	16·5
0·9	139	2·86	0·664	10·02	11·14	56·6	16·0
1·0	132	3·02	0·700	9·75	9·75	55·0	14·0
1·1	126	3·17	0·734	9·46	8·6	53·46	12·3
1·125	124	3·22	0·746	9·36	8·32	52·9	12·0
1·2	121	3·3	0·766	9·2	7·67	52·0	11·0
1·25	118	3·37	0·782	9·08	7·27	51·34	10·7
1 3	116	3·44	0·798	8·93	6·87	50·45	9·8
1·375	113	3·54	0·820	8·77	6·38	49·55	9·5
1·4	112	3·57	0·828	8·7	6·22	49·1	8·9
1·5	108	3·7	0·857	8·475	5·65	47·8	8·1
1·6	104	3·82	0·885	8·299	5·18	46·89	7·6
1·7	101	3·94	0·912	8·10	4·76	45·78	7·3
1·75	100	3·99	0·925	8·01	4·58	45·27	7·0
1·8	98	4·05	0·939	7·91	4·4	44·72	6·7
1·9	96	4·17	0·965	7·73	4·07	43·72	6·2
2·0	93	4·27	0·989	7·6	3·8	42·93	5·7

PRODUCTIONS OF FLY FRAMES.

Roving Frames—Indian and Low American Cotton.

Speed of spindles=1100 revs. per min. | Dia. of front roller = $1\frac{1}{8}$ in.
Dia. of full bobbin = $3\frac{3}{4}$ in. | Lift = 7 in.
Weight of full bobbin = 11 oz. | Time lost in doffing, etc.=13 min. per set.

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist per Inch.	Hanks per Spindle per Day of 10 Hours.	Lb. per Spindle per Day of 10 Hours.	Hanks per Week of $56\frac{1}{2}$ Hours.	Percentage of Time Lost in Doffing, etc.
1·75	155	7·06	2·0	9·29	5·31	52·5	16·0
2·00	146	7·5	2·122	8·84	4·42	49·94	13·9
2·25	138	7·95	2·25	8·55	3·8	48·3	11·9
2·50	131	8·3	2·37	8·25	3·3	46·61	10·4
2·75	125	8·79	2·487	7·947	2·89	44·9	9·1
3·00	119	9·18	2·6	7·71	2·57	43·56	8·1
3·25	115	9·54	2·7	7·47	2·3	42·23	7·2
3·50	111	9·9	2·8	7·24	2·07	40·93	6·5
3·75	107	10·24	2·9	7·05	1·88	39·83	5·9
4 00	103	10·6	3·0	6·8	1·7	38·42	5·4

Roving Frames—American Cotton.

Speed of spindles=1100 revs. per min. | Dia. of front roller = $1\frac{1}{4}$ in.
Dia. of full bobbin = $3\frac{5}{8}$ in. | Lift = 7 in.
Weight of full bobbin = $10\frac{1}{2}$ oz. | Time lost in doffing, etc. =13 min. per set.

2·0	158	6·94	1·767	10·24	5·12	57·85	20
2·5	141	7·76	1·976	9·62	3·85	54·38	14
3·0	129	8·5	2·165	9·06	3·02	51·19	11
3·5	120	9·15	2·33	8·81	2·58	49·77	9·5
4·0	112	9·8	2·5	8·56	2·14	48·36	7·6
4·5	105	10·4	2·65	7·95	1·80	44·94	6·2
5·0	100	10·97	2·795	7·35	1·47	41·52	5·0
5·5	95	11·50	2·93	7·15	1·3	39·32	4·0
6·0	90	12·01	3·06	6·84	1·14	38·64	3·9
6·5	87	12·52	3·18	6·69	1·03	37·06	3·5
7·0	84	12·96	3·3	6·44	0·92	36·38	3·1

ROVING FRAMES—GOOD EGYPTIAN AND SEA ISLANDS COTTON.

Speed of spindles = 900 revs. per min.
Dia. of full bobbin = $3\frac{1}{2}$ in.
Weight of full bobbin = $10\frac{1}{2}$ oz.
Dia. of front roller = $1\frac{1}{4}$ in.
Lift = 8 in.
Time lost in doffing, etc. = 13 min. per set.

Hank Roving.	Revs. of Front Roller.	Turns of Spindle to one of Front Roller.	Twist per Inch.	Hanks per Spindle per Day of 10 Hours.	Lb. per Spindle per Day of 10 Hours.	Hanks per Week of 56 Hours.	Percentage of Time Lost in Doffing, etc.
4·0	104	8·64	2·2	7·6	1·9	42·94	6·2
4·5	98	9·15	2·33	7·2	1·62	40·68	5·3
5·0	93	9·66	2·46	6·9	1·38	38·98	4·5
5·5	88	10·13	2·58	6·65	1·21	37·6	4·0
6·0	85	10·58	2·694	6·36	1·06	35·93	3·5
6·5	82	11·0	2·804	6·11	0·94	34·52	3·1
7·0	79	11·42	2·91	5·88	0·84	33·22	2·8
7·5	76	11·88	3·01	5·72	0·767	32·32	2·5
8·0	73	12·21	3·11	5·56	0·695	31·41	2·3
8·5	71	12·55	3·20	5·42	0·64	30·65	2·1
9·0	69	12·96	3·3	5·29	0·588	29·9	1·9
9·5	67	13·31	3·39	5·17	0·546	29·21	1·8
10·0	65	13·65	3·47	5·05	0·505	28·53	1·7

CALCULATIONS.

$$\text{Change wheel} = \frac{\text{Constant number}}{\text{Draft}}.$$

$$\text{Hank roving} = \frac{7000 \times \text{number of yards taken}}{840 \times \text{weight in grains}}.$$

$$\text{Draft wheel when changing the hank} = \frac{\text{Present hank} \times \text{present change wheel}}{\text{Required hank}}$$

$$\text{Twist wheel} = \frac{\sqrt{\text{Present twist wheel}^2 \times \text{present hank}}}{\text{Required hank}}.$$

$$\text{Lifter wheel} = \frac{\sqrt{\text{Present lifter wheel}^2 \times \text{present hank}}}{\text{Required hank}}.$$

$$\text{Star wheel} = \frac{\sqrt{\text{Present star wheel}^2 \times \text{hank required}}}{\text{Present hank}}.$$

$$\text{Weight per yard of hank roving, in grains} = \frac{7000}{840 \times \text{hank roving}}.$$

$$\text{Time in min. to build bobbin} = \frac{840 \times 36 \times \text{twist per in.} \times \text{hank} \times \text{weight of bobbin in oz.}}{\text{Revs. of spindles} \times 16}$$

$$\text{No. of sets in 10 hrs.} = \frac{600 \text{ minutes}}{\text{Minutes to build bobbin} + \text{time for doffing, etc.}}$$

Lbs. per day of 10 hours = Sets in 10 hours × weight of bobbin in lb.
Hanks per day of 10 hours = Lbs. per day × hank roving.

USUAL WEIGHTS FOR FLY FRAME ROLLERS.

Kind of Machine.	Kind of Cotton.	Front.	Middle.	Back.
		lb.	Lb.	
Slubber	Indian, American and Russian . .	18	24 Saddle and Bridle	
,, ...	Egyptian and Sea Islands . . .	16	20 ,, ,,	
,, ...	,, ,, ,, . . .	14	12	Self-weighted
Intermediate . . .	Indian, American and Russian . .	16	20 Saddle and Bridle	
,, . . .	Egyptian and Sea Islands . . .	14	18 ,, ,,	
,, . . .	,, ,, ,, . . .	12	10	Self-weighted
Roving	Indian, American and Russian . .	18	24 Saddle and Bridle	
Roving and Jack . .	Egyptian and Sea Islands . . .	16	20 ,, ,,	
Roving	,, ,, ,, . . .	10	Self-weighted	Self-weighted
Jack	,, ,, ,, . . .	8	,, ,,	,, ,,

CHAPTER IV.

MULE SPINNING.

Q. 1898. What should be the character of the rovings presented for spinning; and what are the chief faults it is desirable to avoid?

A. The rovings should be first of all of the proper dimensions or hank for the counts of yarn to be spun from them. They should also be uniform and clean, and free from stretched portions. The bobbins should not be run off at the ends, nor too soft. The rovings should be free from slubs, and "thick" and "single" and "bad piecings". One of the greatest defects is lack of uniformity in counts, and, therefore, in most mills where great uniformity is essential double roving is used at the mule. "Thick" and "single" are sometimes present to a serious extent, and are usually due to carelessness on the part of the operative on the fly frames.

Q. 1900. What is spinning? How is it effected? What are the differences in the methods adopted, and which of the latter should give the best results, and why?

A. Spinning is the art of combining, drawing out and twisting together individual fibres so as to produce a thread which is longer than any one fibre. Cotton spinning implies, in its widest sense, the whole of the operations involved in converting the raw material into the final spun yarn. In its most restricted sense "spinning" means the final process of the series. There are two principal types of cotton spinning machine now in extensive use, *viz.*, the continuous system, as represented by the ring frame, and the intermittent system, as represented by the self-actor mule. In each case the attenuation of the cotton is chiefly performed by the action of three pairs of drawing rollers, and the twisting by

means of very rapidly revolving spindles. While the ring frame is very much the simpler machine, the mule, if properly worked, is likely to give the more perfect thread on account of successive short lengths being individually treated, and because the principles of "gain" and "ratch" can be added to the action of the drawing rollers.

Q. 1901. Describe the cycle of operations in mule spinning, and say what changes the roving undergoes.

A. The cycle of operations in mule spinning may be divided out as follows for an ordinary mule for medium counts of yarn :—

(1) Drawing-out and twisting of the roving, accompanied by the outward motion of the carriage, in order to keep the threads under tension. At this time we have the three principal spinning motions of the mule at full work, *viz*., the rollers, the spindles, and the carriage.

(2) As it is unlikely there would be twisting at the head in the case under description, it is probable that backing-off would take place as soon as the carriage got out. As a matter of fact, serious attempts are being made to make such mules back-off before they get fully out. Backing-off principally implies the reversal of the spindles, and the changing of the faller wires from spinning to winding-on position.

(3) *Winding-on.*—As is well known the mule is an intermittent machine, in which winding-on is stopped during spinning, and spinning in many cases is entirely stopped during winding-on. At the time of winding-on the spindles are rotated at a varying rate of speed by the action of the quadrant, while at the same time the faller wires are controlled and guided by the copping rail and connected mechanism, the wires in turn guiding the threads properly upon the cops. The carriage during the run-in is pulled by the thick scroll bands, and during spinning by the back shaft bands.

(4) Unlocking of the fallers implies the return of all the parts from winding-on to spinning position, and in its entirety is the converse operation to backing-off.

It may be added that it would have been quite possible to divide out the cycle of motions still further by taking arrestation of parts, locking of fallers, etc., as separate periods.

Q. 1896. What is a loose boss roller? In what machines is it used? Give a sketch distinguishing the parts.

A. In the loose boss roller the leather-covered portions are not secured to the spindle or shaft as in fast rollers, hence the term "loose boss" or "shell" rollers. The boss or shell rides loose upon a centre spindle, having a barrel-shaped body. The spindle or shaft is stationary, and therefore the "necks" or "saddles" and "roller ends" do not revolve as in a fast roller, but are stationary, and do not gather dirt and fly as in a fast or solid roller. This is a point which puts it in great favour with some spinners and other operatives. It also follows as a matter of course that these "ends" and "necks" being no longer "bearing" or "friction" surfaces do not require any oiling or "tallowing". Loose boss rollers are now very commonly used for the front line of rollers in the drawing frames and subsequent machines. They are more expensive than solid rollers, and as their use in the middle and back lines of rollers could scarcely be of much advantage, it is seldom that they are used for those rows of rollers. They were the invention of Mr. Evan Leigh, who left the stamp of his inventive genius upon several other things about cotton spinning machinery, as, for instance, the "Flexible" bend for carding engines, which is very largely used at the present time, and which several eminent firms of machinists have found it very difficult to improve upon, as they have reverted to it again after having discarded it for several years. Loose boss rollers only require oiling at intervals, as for instance, upon a mule spinning Oldham counts, say about 32's, the shells might be taken off and the spindles cleaned and oiled about every four weeks. In doing this sometimes the spindles are allowed to fall, and, if the floor be of stone, the spindle breaks, and this must not occur too often, or trouble will follow with the management. The author would like to impress all concerned with the importance of using good oil for these shell rollers, as he has often known them to heat and run badly through bad oil being used. This, of course, means bad spinning and badly drawn yarn. Some people prefer the solid roller, but they are in the minority, as the balance of advantage seems to be decidedly in favour of the "loose boss". The author has often marked the two "shells" of a loose boss roller with chalk and watched them run a short time. The result has generally been that one chalk mark has soon left the other, and it must be of advantage to the yarn to let each boss

work independently of the other. Discrepancies in the covering do not by this means affect the yarn to the same extent. Loose boss rollers generally appear to be rather more heavily weighted than solid rollers. It should be just mentioned that rollers with loose ends and metallic drawing rollers are also now rivals with the solid and shell rollers, at any rate for drawing frames.

Referring to Fig. 51, it is seen that the inside spindle, A, is surrounded by the leather-covered shell rollers, b.

A is stationary, and therefore little dirt accumulates on the neck at C, or on the ends of the rollers.

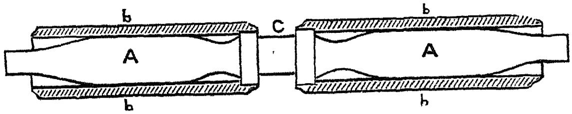


FIG. 51.

Q. Give the lengths of stretch commonly used for the several counts of yarn, and what are the objections to a short stretch?

A. By stretch is here meant the distance the carriage moves from its innermost to its outermost position.

Very fine yarns . .	50 in. to 57 in.
Moderately fine yarns .	60 ,, to 64 ,,
Medium counts . .	64 ,,
Coarse counts . .	66 ,, to 72 ,,

The use of a short stretch involves a great loss of time in backing-off and running-up, while a very long stretch results in the threads breaking excessively during the last few inches.

Q. What is meant when we say that yarn is spun twist way or weft way?

A. When we look down on the spindle points at the mule, ring frame, or the bobbin and fly frames, and the spindles are revolving the same way as we should turn a screwdriver in screwing up, it is termed twist way, while the opposite is weft way.

Q. What is meant by the gauge of spindle in mules? State the different gauges commonly in use for different counts of yarn.

A. *Gauge* is the distance from centre to centre of adjoining spindles, and the gauges most used are as below:—

For twist cops, most numbers . .	$1\frac{3}{8}$ in.
For pin cops, most numbers . . .	$1\frac{1}{8}$,,
For twist cops, fine counts, very often .	$1\frac{5}{16}$,,
Occasionally for pin cops . . .	$1\frac{1}{10}$,,
Occasionally for bastards . .	$1\frac{1}{4}$ or $1\frac{5}{16}$,,
For very coarse counts, twiner doubling and waste spinning . .	$1\frac{1}{2}$ to $2\frac{1}{2}$,,

Fine Winding Motion and Hastening Motion.

Motions which were applied to the Threlfall fine mule many years ago are not only successfully working to-day, but other makers have deemed it advisable to apply practically the same motions in some cases to their fine mules. The motions alluded to are such as are special to the spinning of very fine numbers. The *fine rim motion* is an instance of what is now referred to. This motion in principle of action closely resembles the hastening motion so largely applied to medium spinning mules using American cotton. In each case the "winding on" is more or less transferred from the winding drum to the rim shaft just before the carriage reaches the back stops, with the result that the spindle speed is increased at the termination of winding on.

There is, however, this great difference between the two: Whereas the hastening motion causes the ordinary down belt to take control of the rim shaft, and consequently the winding on, the "fine rim motion" causes a special thin belt to move upon a very narrow pulley fast on the rim shaft, and the resultant acceleration of spindle speed is extremely moderate as compared with that obtained by the "fine-rim motion". The speed given by the latter can in fact be any speed between that given by the winding drum and that given by the down belt, as may be required. In this way it is sought to obtain the possible advantages of the hastening motion without the great disadvantages of cut yarn and bad spinning, which sometimes have resulted from over application of the hastening motion. The writer is by no means certain that this fine winding motion would not be an advantage for medium numbers as well as for fine numbers, although its application involves the use of extra fast and loose pulleys, an extra down belt and an extra top driving pulley. It ought to be stated, however, that many operative spinners on fine

numbers do not appear to care much for this motion, just as many spinners on medium numbers do not care for the hastening motion. The fine winding motion is applied now to several makes of fine spinning mules, and may have sufficient power to just draw out the carriage at a snail's speed if the ordinary down belt be left on the loose pulley, while the winding motion belt be left on its fast pulley. This, however, depends partially upon how much the winding on belt is allowed to bite upon the fast pulley. There are two principal adjustment places about the motion, one of which determines the exact moment when the narrow belt shall move from the loose to the fast pulley as the carriage reaches the termination of its outward motion, and the other determines the exact amount by which the narrow winding belt shall be allowed to bite upon its fast pulley. In this way the spinner can easily regulate the time of action and the amount of action of this motion. In some cases, however, the overlooker fixes these parts in certain positions, and gives instructions that the spinner must not shift anything, the same plan being sometimes followed in regard to the hastening motion. Spinners are occasionally tempted to over-apply the latter motion on account of its giving a slight impetus to the carriage at starting out from the roller beam, although such jerky motion may be detrimental to the yarn. Occasionally, also, this jumping out of the carriage has been the cause of breakages of the wheels concerned in rotating the back shaft. Some spinners prefer to put it out of action for about 30 minutes after doffing.

Q. What is the influence of the weather on the processes of spinning?

A. It is the general experience that warm, moist weather is the very best for the processes of cotton spinning.

It is not sufficient to have either heat without moisture or *vice versâ*. Heat is necessary to keep the machinery in the best working condition, while it also softens the waxy portion of the fibres of cotton, and therefore keeps the fibres in a pliable condition.

Moisture is necessary in order to prevent the fibres from becoming parched and dry, and to prevent the fibres from being susceptible to the influences of electricity. It is the author's experience that dry, hot summer days, dry, frosty days, and days on which east winds are prevalent are the

worst of all for the various processes of cotton spinning. Black, foggy days are also very bad, because they tend to dirty the cotton.

Q. Name the highest numbers that have been spun advantageously on the throstle and ring frames, and say why as high a rate of numbers cannot be spun on these frames as on the mule.

A. (*a*) It is probable that a strong yarn of about 30's may be put down as the limit for the flyer throstle, owing to the strain of pulling the bobbin round devolving on the yarn.

(*b*) On the ring frame a vast deal depends on the kind and quality of the rovings supplied to the ring frames. At the present time a large quantity of yarn from 70's to 80's, is being spun from combed Egyptian and Sea Islands cotton double roving. A limited amount of 110's is spun in England on the ring frames.

From good American cotton, double roving, carded, the safe limit may be put down at about 50's, and for single roving, say, 40's.

Finer and more delicate yarns can be spun on the mule, because in the latter the yarn does not have a traveller to pull round as on the ring frame, and also because spinning is practically discontinued while winding-on is done.

Driving of Rollers and Carriage.

Referring to Fig. 52, the wheel I, on the back of the rim shaft gives motion to the larger wheel J, while on the same stud as J is wheel K, giving motion to the large drawing-out or back change wheel, L. On the opposite end of the side shaft the bevel wheel, A, gives motion to B, which is part of the roller clutch-box.

This is the first half of the mechanism by which rotation is transmitted from the rim shaft, revolving at perhaps 750 revolutions per minute.

It will be noticed that a larger wheel, L, would *slower* both the carriage and roller speeds equally.

The *second part* of the motion begins with wheel C, which is part of the clutch-box, on the front roller spindle. Wheel C, by means of carrier D, gives motion to the wheel E, which is the change wheel for "drag" or *gain of carriage*. A

larger wheel at E would reduce the speed of the carriage without affecting the speed of the rollers, and thus reduce the amount of "gain," or carriage draft.

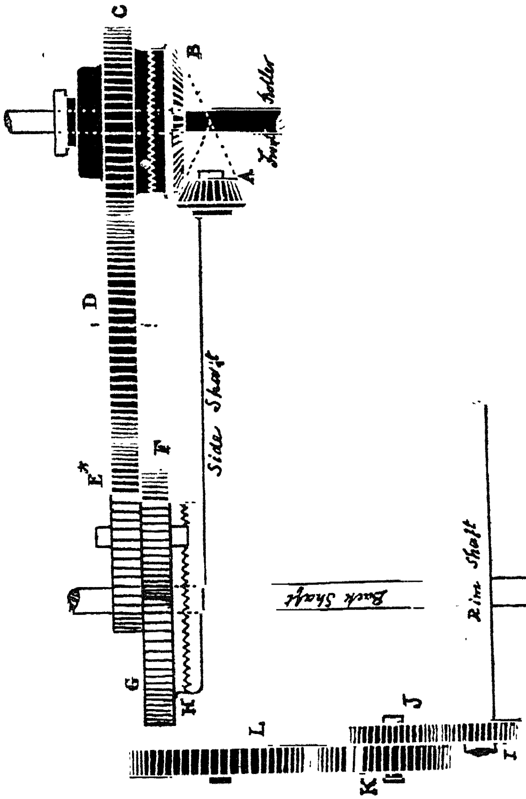


Fig. 52.

On same stud as E is the small wheel F, which drives the large wheel, G, on the back shaft. Compounded with G is the loose half of the back shaft clutch-box, H.

During spinning and outward motion of carriage the clutch-boxes at B and H are closed, and the rollers and back shaft are rotated. Just prior to the carriage finishing

its outward motion it is customary to open these clutch-boxes, thus disengaging rollers and carriage.

The Internal Disc of a Roller Box.

The author has often been asked about the special use of the internal disc, which appears to be an indispensable part of the roller-box mechanism of an ordinary mule.

Let us suppose that we have no such internal disc, but just simply the two halves of the roller box, with the driven half working on a feather key fixed in the front roller spindle. The driving would probably proceed all right during the outward motion of the carriage, and it might be quite possible to slide the driven half along the feather key out of gear when the carriage got out, and also to fulfil all that was required to be done during all the stages of an ordinary mule.

But to the reflective mind it will at once be evident that the internal disc arrangement is far preferable to the feather-key method. It appears to the writer that in favour of the disc it may be said—(1) it is far stronger and less liable to go wrong than a key on which the box has to be slided; (2) it is far easier to open and shut the box; (3) it allows the ready application of a certain type of anti-snarling motion which is much in vogue on different makes of mules.

It appears impracticable to rigidly key the driven half of the roller-clutch box on its shaft, because then it could not be slided in and out of gear. We cannot rigidly key the driving half of the roller box to the spindle, partly because it has a slight motion given to it incidentally from the rim shaft during winding-on.

Clutch-boxes have been tried for winding-on, but danger of fire due to quickly running teeth striking on the points has led to abandonment. Frictions have also displaced boxes for cam shafts.

Double Roller Box.

On many fine spinning mules there is a most ingenious extension of the roller-box principle which does not appear to be very well understood, even by many practical men who actually have to deal with it.

As stated above, in an ordinary roller clutch-box it is necessary to provide for certain contingencies: (1) The driving half must be loose on the front roller shaft; (2) the driven half must be capable of sliding along the shaft; (3) the "drag" or "gain" train of wheels must be disconnected during winding-on. Referring now more especially to Dobson's fine mule, all these contingencies must be provided for, and, in addition, the rollers must be disconnected during the jacking motion of the carriage.

Most of our readers know very well that by "jacking" or "ratching" is meant that the rollers are disconnected before the carriage gets fully out, say anything up to four or five inches, the finest yarns and best cottons taking the most ratch. Assuming that two inches of ratch is being put in, then in some Dobson's mules two inches before the carriage gets out the roller box would be opened, thus disconnecting the principal train of wheels by which the rollers and back shaft are driven. At the same instant, however, the jacking motion wheels take command of the "gain" series of wheels, and in this way the outward motion of the carriage is terminated at about a fourth or a fifth the full spinning speed.

The point which we here desire to specially make clear is that with the ordinary roller box the wheels of the jacking motion would impart motion to the rollers as well as the carriage.

To put the position in a general way, it may be stated that if ordinary driving and driven halves of a clutch-box and an internal disc are essential to get good results without jacking motion, something more is necessary when the jacking motion is applied of the make under discussion.

In Dobson's fine mule this requirement is effectively and cleverly provided for by making a double roller box, one box working absolutely inside the other, and both boxes being opened and closed by the same fork. Each box has, however, quite different work to do. In an ordinary roller box the driven half of the same box drives both rollers and carriage; the latter by means of a sleeve and the former by means of the internal disc. In this double roller box the outside box attends entirely to the driving of the carriage, and has no connection with the rollers whatever. The inside box is connected to the front roller by means of the internal disc,

and this drives the rollers in the usual manner, but has no connection with the driving of the carriage. As stated, both boxes are opened and shut by the same fork, only the driven half of clutch is doubled.

The inside box is so ingeniously fitted to the outside one that even a practical man may often look at the arrangement and fail to notice the exact use and operation of each box. The outside box is quite free from the front roller, so that the driving half can be rotated loosely during winding-in, and the other half loosely during jacking. The action of the two boxes may now be more clearly stated. As the carriage comes out both boxes are engaged, and the external box is driving the carriage while the internal one is driving the rollers. When jacking commences both boxes are opened, and the driven half of the external box is slowly rotated by the jacking motion wheels without in any way affecting the inside box or the rollers. Cases have been known where the external and internal boxes have somehow become so locked together that slack yarn has been caused during jacking, owing to the jacking motion wheels driving the rollers, and this is a point requiring the attention of practical men in charge of these motions, as well as noting that both internal and external driven halves of roller box are properly geared and ungeared as required.

A principal reason why this motion is not better understood is because the internal box is so completely inside of and identified with the outer one.

The jacking delivery motion or receding motion may take charge of and rotate the rollers and the driven half of the internal box without affecting the other parts. The same may be said of the winding delivery motion during winding-on.

To the driven half of the internal clutch-box may be attached a lace and weight arrangement, after the style of that attached to many snarling motions. In this case the lace steadies the inside box—tends to keep it from being affected by the external one during jacking.

Q. 1900. What are the essential properties of good yarn for twist and weft? Give these in the order of importance for each class, and say how the method of preparation affects each property, favourably or unfavourably.

A. It is essential that yarns possess the following qualities: uniformity of counts, sufficient strength, uniformity of colour, elasticity, a suitable amount of twist, freedom from leap, nep sand, etc. Uniformity of counts is essential in all yarns; strength is most essential for warp yarns and thread, because of the strain imposed upon these threads in subsequent operations. It is by no means as necessary in weft yarns to the same extent. Colour is not of great consequence in some warp yarns. Weft yarns, having only to carry across the loom, are relatively weaker, and have less twist per inch because of this, and often also to give a better cover and softer feel to the cloth. Many buyers of yarn also find it necessary nowadays to ascertain whether it is sufficiently free from added moisture. The scutching and carding processes are responsible for nearly all the cleaning or the want of it, while the drawing frames render vast assistance in giving strength and uniformity to the yarn. Although the fly frames are mainly concerned in reducing the cotton to a sufficient degree of fineness, it is possible for soft, thick portions of yarn to have their origin in the fly frames.

Q. 1898. Describe in detail the mechanism used to draw out the carriage of a mule. Give a sketch.

A. The mechanism used for drawing out the carriage of a mule may be divided into two parts: first, that portion which is employed for driving the long back shaft of a mule; secondly, that which is used to convey motion from the back shaft to the carriage of the mule.

The back shaft of a mule is always driven from the rim shaft, and since the back shaft may only make about 3·5 revolutions during one outward traverse of the carriage, while the rim shaft may sometimes make upwards of 170 revolutions in the same time, it follows that we must have small wheels driving large ones. A common plan is to have three small wheels, each driving a larger one, the third of which is on the front roller. From the front roller a small wheel drives by means of a carrier the large drag or gain wheel, and on same stud as the "gain" wheel is a small wheel driving the large back shaft wheel. The method of driving enables both the speed of the rollers and that of the carriage to be altered simultaneously by the speed wheel, or the carriage speed only to be varied by the "gain" wheel.

On the back shaft are keyed a number of scroll drums, to

each of which are attached two carriage bands, the other end in each case being attached to the carriage by adjustable racks. A very short mule may only have three such pairs of bands, one pair at each end and one in the middle, while a very long mule may have seven such pairs, and a medium length of mule may have five pairs. Each pair of bands consist of a long band and a short one. Assuming that the carriage is beginning to move outwards, the back shaft will be driven as above described, and will begin to wind on its scrolls the long carriage bands. Each of these bands reaches outwards, and passes over a guide pulley at the extremity of the "stretch" before being attached to the carriage, so that the winding of these bands upon the back shaft causes them all to draw out the carriage until the limit of the stretch is reached and the back shaft is stopped. The short draw-bands at this time only steady the carriage and keep it square, being of greatest use during the return journey of the carriage.

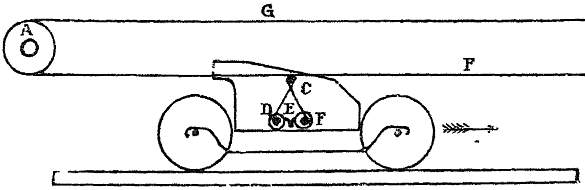


FIG. 53.

Fig. 52 clearly shows how the back shaft is driven from the rim shaft.

Fig. 53 shows the connection of one pair of carriage bands from back shaft to carriage. G is the top band which draws out the carriage; F is the short bottom band; A is a guide pulley for top long band; B is the back shaft scroll; at D, E, F are tightening racks in the carriage, by which the tension of the bands can be adjusted. It must be understood that both bands are fastened to the scroll at B, and as one winds off the other winds on. The arrow indicates running-in of the carriage.

Q. 1898. Describe and sketch the method of balancing the counter-faller wires in a mule, and say how they are prevented from coming into contact with the threads during the period of spinning.

A. Attached to the counter-faller shaft are several part circles or pulleys, say half a dozen in the length of an ordinary sized mule. From each part pulley is pendant a chain, whose bottom end passes through a weight fulcrumed underneath the carriage. This weight is kept off the "button" of the counter-faller chain during spinning and twisting by resting on the "button" of the winding-faller chain. Immediately the winding-faller begins to be pulled round by the backing-off chain the weight devolves upon the "button"

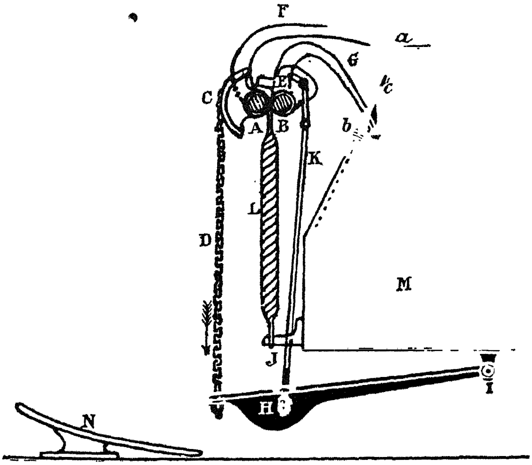


FIG. 54.

of the counter-faller chain, and thus begins to rotate the counter-faller shaft, and to raise the counter-faller wire upwards until it presses beneath the threads. This action continues until the fallers unlock at the termination of winding-on. Each weight carries a vertical stud, upon which movable weights are placed, and the number of these is regulated according to the degree of tension it is desirable to put upon the threads during winding and the degree of hardness required in the cops. In Draper's recently devised motion a rolling weight applies more weight to the threads during backing-off. In another case the salmon head lever is in two halves, one only of which is released during backing-off.

Fig. 54 and accompanying description will make these remarks clearer.

Salmon Head Levers, or Counter-faller Motion.

Referring to Fig. 54, B is the winding-faller shaft; A is the counter-faller shaft; C is the sector or part circle to which is secured the chain, D, and which is itself secured to the shaft, A; E is the adjustable finger, to which is fastened the back chain or rod, K, and which acts as a stop or finger to prevent the winding wires from rising too high during spinning.

It must be understood that the various parts are shown in winding-on position. F is the counter-faller sickle and G

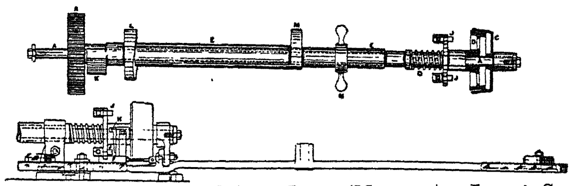


Fig. 54a.—Cam Shaft and Long Lever (Messrs. Asa Lees & Co.).

References to Diagram.

A Cam shaft.
B Cam shaft wheel.
C Friction cover keyed on cam shaft.
D Friction cone keyed on the cam shell.
E Cam shell.
F Adjustable bracket to carry steel incline.
G Long lever.
H Steel incline on long lever.
J Stop studs fixed in friction cone.
K Taking-in lever cam.
L Strap guide lever cam.
M Cam to operate front spindle catch box.
N Cam handle.
O Cam spring.

the winding-faller circle; *a* is the yarn, *b*, *c* the spindle and M the carriage; H is the salmon head lever fulcrumed at I, while L is the spring which pulls up the winding-faller when the fallers are unlocked; N is the floor incline, upon which the weight, H, rests during backing-off, thus relieving some of the tension from the yarn.

During backing-off the weight, H, pulls up the counter-faller and keeps the threads at *a* under tension during winding-on. When the fallers unlock the rod or chain at K lifts up the weight, H, and the spring, L, returns all parts to spinning position.

Cam shaft and Long Lever.

The various changes in the working of the mule are effected by the cam shaft and long lever illustrated on the preceding page. The cam shaft arrangement has been proved to be the most positive method of operating these changes. The cam-shaft forming the three cams is cast in one piece, the cams, therefore, always retaining their relative positions. Each end of the cam shell, where it runs on the cam-shaft, is bushed with brass.

The cam-shaft A is driven from the backing-off wheel by means of the pinion B, which is keyed on the shaft, and on the other end of the shaft is keyed the friction cover C, which is, consequently, in motion all the time the mule is working. The friction cone is keyed on the cam shell and when the long lever changes at the termination of each run of the carriage it is forced into the friction cover by the spring O and thus causes the cam shell to make a half revolution. After this half revolution the friction is released by one of the studs J coming in contact with the incline H, and remains free until the long lever changes again, when it is again put into gear and makes another half revolution, thus completing the cycle of changes.

The steel incline, of which there were formerly two fixed to the friction cone, is now carried by the adjustable bracket F, while the stop studs, which were formerly on the long lever, are now fixed to the friction cone. This arrangement prevents any variation in the changing due to unequal wear of the inclines. The inclines and the studs are all fixed by setscrews and not by rivets, and can therefore be easily changed.

Q. 1900. How are the rollers of a mule driven from the rim shaft? How are they engaged and disengaged, and at what points during the cycle of operations?

A. It is the common practice in modern mules to drive the rollers from the rim shaft by a train of, say, six wheels, part of which are spur wheels and the others bevel wheels. In some headstocks, such as Platt's and Dobson's, about four of the wheels are at the back of the headstock; while in others, such as Asa Lees' and Hetherington's, all the wheels are at the front of the driving pulleys. The principle of action and the objects aimed at are in every case the same. In each case the front roller is driven round at a slow speed from the quickly running rim shaft by having small wheels driving

larger ones. In each case one of the wheels is the change wheel for speed, by which the speeds of the rollers and carriage can be altered readily without affecting the speed of the spindles.

In every case the last wheel of the series is placed loosely on the front roller, and is compounded with one half of the roller clutch-box. The latter is usually opened just as the carriage terminates its outward motion, and is closed just at the termination of the inward run of carriage; the engagement and disengagement being effected by rods, levers and springs operated in some cases by the movement of the carriage, and in other cases by the partial revolution of the cam-shaft or shell. When the ratching or jacking motion is applied, the roller-box is opened just previously to the carriage getting out; and in some applications of anti-snarling motions its effective re-engagement is delayed until just after the carriage has started out again. The driving of the rollers from the rim shaft is shown clearly in Fig. 52, and below are given sketches and descriptions of the engagement and disengagement.

Engagement and Disengagement of Roller-Box.

Index of Parts.—Figs. 55 and 56 refer to one long-established method. V_1, V_2 are two adjustable fingers fastened to the long rod, V; T, T^1 is a slotted lever working on the fulcrum, W; Z is a stud secured to rod, V, and capable of movement in the long slot at T^1; Q is a finger forming part of the bell-crank lever, Q, P, O, fulcrumed at R; I is the roller-box wheel driven by wheel, J; F, R is the front roller; N is roller-box fork, and S a spiral spring which keeps the box closed.

Action of Parts.—When the carriage gets almost out it carries a stud which comes against the adjustable finger, V_2, and thus moves the long rod, V, in the direction indicated by the arrow on the right hand. The movement of rod, V, slides the stud, Z, along the slot, T^1, and thus oscillates the lever, T, T^1, on the fulcrum at W.

The effect of this is to press upwards at Q (Fig. 56) and rock the bell crank lever, Q, P, O, on its fulcrum, R, thus moving the fork at N in the direction shown, and, there-

fore, to overcome the resistance of the spring, S, and to open the clutch-box between M and I.

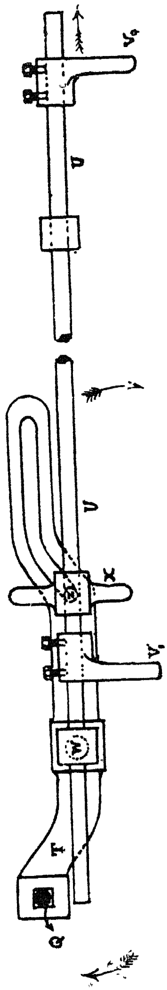


FIG. 55.

The clutch-box always remains open until the carriage has almost completed its inward journey again, when it is closed by a stud carried by the carriage square coming against the adjustable finger, V^1.

In this way the rollers are continually engaged and disengaged so long as the mule is working.

The arrow at N, in Fig. 56, indicates

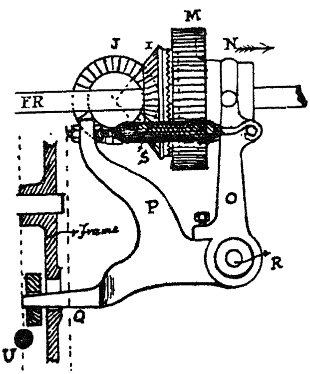


FIG. 56.

the direction of movement when the box is being opened.

The fingers, V_1, V_2, are made adjustable in order to have the rollers engaged or disengaged sooner or later, according to the judgment of those in charge. About 1910 Messrs. Dobson & Barlow began to apply a more instantaneous method of opening the roller-box and this has proved very successful.

Q. 1899. Describe in full detail and sketch the rim shaft and parts upon it of a mule headstock? How is the rim pulley fixed to the shaft? What would be the effect if the angle of the friction cone was (*a*) too acute, or (*b*) to obtuse?

A. Take the special Threlfall headstock. At the front end is secured the double speed rim pulley, and near to it the shaft rests on a suitable bearing. Proceeding from this end there is a single worm secured in front of the brake friction, and this worm gears into and drives the 55 wheel of the twist motion. Then after a bearing comes the brake friction, which acts on the fast pulley of the double speed rim shaft. Then we have the three belt pulleys: (1) The pulley fast to the front rim shaft; (2) the middle or loose pulley; (3) the fast pulley of the back or single speed rim shaft. Then we have two narrow belt pulleys, one of which is fast to the back rim shaft, and forms what is termed the rim or snicking motion. The other pulley is connected with a long boss running loose on the shaft, and carrying a wheel which is the first of a train of wheels, whose duty it is to drive the large backing-off friction wheel. Then we have the backing-off friction and wheel, followed by a bearing and a driving wheel. Finally, the small back rim pulley. A common method of fastening the rim pulley to the rim shaft is to forge on the end of the shaft a special boss or plate and to have three bolts coupling this plate to the rim pulley. The latter is also held in position by a couple of nuts screwed on the end of the shaft. If there is too small an amount of taper in the cones the movement for engagement and disengagement will have to be too great, while if the taper is too much there will not be a sufficiently tight grip. In some cases the cones have had such a small amount of inclination that it has resulted in ineffective disengagement. It must be distinctly understood that there are two separate rim shafts placed end to end inside the loose pulley No. 2, in Fig. 57.

Q. 1901. What is the object of double speed in a mule for spinning fine counts? Describe any motion with which you may be acquainted.

A. The object of double speed in a fine spinning mule is to allow a very moderate spindle speed during the outward motion of the carriage, and then to give a high speed of spindle during twisting at the head. The low speed of spindle during the outward motion of carriage facilitates the insertion of a good deal of "ratch" and "gain," as it leaves the yarn so soft as to readily yield and draw out without breaking. If this low speed of spindle were maintained during twisting at the head there would be a loss in pro-

duction, which is prevented by using single and double speed.

Referring to Fig. 57, which shows Threlfall's double rim shaft, the index of parts is as below :—

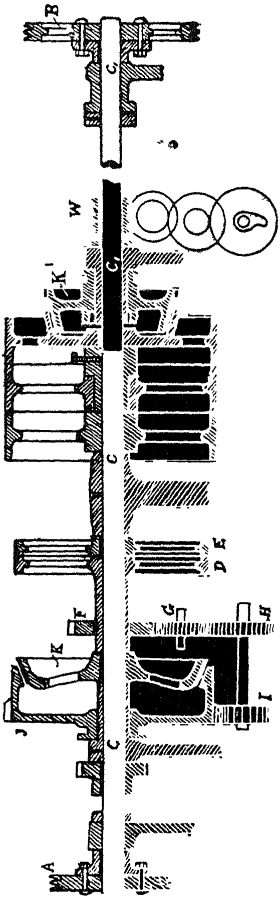


Fig. 57.

A is the back or single speed rim Pulley.
B is the front or double speed rim Pulley.
C is the back rim Shaft.
C¹ is the front rim Shaft.
D Pulley fast on long, loose Boss, its object being to give motion to the Wheels, F, G, H, I, J, of which J is the large backing-off cone Wheel.
E is the rim or snicking motion Pulley fast on the back rim Shaft, C.
K is the backing-off friction.
K¹ is the break friction, or assistant to K.
W is the twist Worm, giving motion, as shown, to the five Wheels of the twisting motion.
1 is the Pulley fast to back rim Shaft, C.
2 is the loose Pulley.
3 is the Pulley fast on front rim Shaft, C¹.

In the 1915 additions to this chapter will be found sketches and descriptions of another single and double speed arrangement.

Fig. 57 shows a good example of a single and double speed motion as made by Messrs. Threlfall when required.

The rim shaft is of great length, and is really in two separate halves, C and C^1, joined up end to end inside the loose pulley, No. 2, which is not the case in other mules.

The front rim, pulley B, is much larger than the back one, A. As the carriage is coming out the belt is on No. 1 pulley and the small back rim pulley is driving the spindles at a moderate speed, the front rim pulley being at this time simply a carrier.

Just before the carriage gets out the belt is moved from No. 1 to No. 3 pulley, going straight across the loose pulley, No. 2. The large front rim pulley, B, thus temporarily becomes the driver of the rim band and spindles, while the small back rim pulley in its turn becomes merely a carrier. The difference in spindle speed for single and double speed is of course represented by the difference in size between pulleys A and B.

Independent Backing-off.

The author has before referred to the difficulty experienced in some cases in regard to the backing-off when the rim pulley of a self-acting mule is from some cause varied in size to a considerable extent. Take the case of a mule which it is required to change from very low counts, such as 8's, to medium counts, such as 30's. It is highly probable that in such a case it will be required to apply a much larger rim pulley for the 30's than the one used for the 8's. Granting that the speed of backing-off was previously correct for the 8's, it is to be reasonably expected that for the 30's the speed of backing-off would be so excessively quick as to injure and break the threads. If, on the other hand, the change is from 30's to 8's, and the reversal of spindles and faller-wires was right for the 30's, it is probable that for the 8's the reversals would be performed in a miserably slow and halting manner. The writer speaks from experience in this matter, and in such cases has not found it possible, by any rearrangement of the springs, rods, levers, and frictions belonging to the backing-off mechanism, to bring about a satisfactory speed of backing-off.

The small wheel, which in nearly all headstocks, gears into and drives the large backing-off friction wheel, is in such a cramped position that to effect any appreciable altera-

tion in its size appears in the majority of cases to be quite impracticable. It is equally, or even more, impracticable to think of effecting an alteration in the size of large backing-off wheels, while if any of the wheels and pulleys which are farther away from the large friction wheel are altered, then the speed of drawing-up is equally affected with that of the reversal of spindles and faller-wires.

New Change Wheel.

It is the author's opinion that a convenient rearrangement of the side shaft, which would allow of making the wheel which gears into and drives the large backing-off wheel into a change wheel capable of being altered with the same facility that the twist, speed and draft wheels can be altered, would confer an advantage in the mule which would be greatly appreciated by very many minders, overlookers and managers. It might even pay to place a couple of carrier wheels between the driver and driven wheels if no better means could be provided.

One eminent firm of mule makers have become identified with special mechanism meeting such cases as the one under discussion. In this invention a special short shaft is fitted over the large backing-off friction wheel, containing a small pinion to drive the large wheel. On the same short shaft is fitted a stepped speed pulley, driven by a rope extending from a similar stepped speed cone on the counter shaft. The whole arrangement is an application of the principle of the speed cones so largely used on lathes, and it constitutes a very ready and very effective means of securing any desired speed of backing-off by simply transferring the rope from one pulley to another. Objections which the writer can see to this motion are that it adds additional mechanism, and its alteration affects also the speed of cam-shaft.

Rope-taking-in.

Between the novel apparatus for driving the backing-off in a manner independent of all motions and what is often termed rope-taking-in there is a very close resemblance. The latter is an example of additional mechanism being adopted to do certain work, and in the course of a few years

winning its way thoroughly into public favour. The rope-taking-in controls everything about the working of the three frictions of a mule, namely, the backing-off friction, the cam-shaft friction and the taking-in friction. The new independent backing-off isolates the backing-off from the taking-in mechanism, although the writer is of opinion that the case would be satisfactorily met by simply providing better means for varying speed of backing-off, with less added mechanism.

Independent driving for the backing-off and taking-in mechanism is not as recent as some people appear to imagine. As a matter of fact, the Threlfall hand-mules, as made nearly half a century ago, had such independent driving—belt driving being preferred to driving by ropes.

The writer has had considerable experience both on mules driven in the independent manner from the counter-shaft, and on others in which the backing-off, winding-on, and changing mechanism were actuated by a connection of wheels from the loose pulley of the machine, and can testify that the independent method is far superior to the other one, in spite of the extra mechanism involved. On very fine spinning mules it is often preferred to have an independent belt instead of a rope, principally because the belt allows better facilities for varying the speed of the run-up than the rope. It is the writer's experience that the ropes are far better than the belts for medium and coarse mules in which quick and positive driving are of primary importance.

Q. What is the object of putting up double roving at the mule or ring frame?

A. To produce to more uniform yarn, and therefore a much better and stronger yarn.

Q. What are the advantages and disadvantages of weighting the rollers in a mule by levers or dead weights?

A. The lever weighting enables a good deal of weight to be applied to the rollers without using big, clumsy weights, and is therefore well suited to the long top rollers in general use for American and Indian cottons.

With lever weighting the weight can be easily varied to suit different requirements.

In fine spinning, however, the back and middle rollers are generally self-weighted and the rollers are short, and only the front roller needs supplementary weighting. In such

cases it is by far the better practice to suspend dead weights of 4 to 6 lb. from the front rollers.

Q. Give your opinion of single-boss rollers, and say for what range of numbers they are best adapted.

A. The short rollers are the best for fine counts, because of having only one boss to serve for each thread, and one thread cannot affect the drawing of the others, and inequalities in the coverings do not show up as much as with the longer rollers. The short rollers also lend themselves readily to the large drafts and to setting front and middle rollers inside the staple, by allowing a very light middle roller to be used.

They are too dirty and there are too many roller ends and middles to be suitable for low counts.

Drag or Gain, and Ratch.

Q. 1896. What is the carriage gain in a mule, and how is it obtained? What is its chief value? Sketch in outline the gearing driving the back shaft, and indicate the wheel by which the gain is regulated.

A. By "gain" is meant the excess surface speed of the carriage over the surface speed of the rollers during any one stretch. Often the term "drag" is used instead of the term "gain". If 62 inches of yarn are delivered in a 64-inch stretch, there is said to be 2 inches of "gain". It serves the double purpose of keeping snarls out of the yarn, and of making the latter more uniform by tending to draw out any places in the yarn which may be slightly thicker and softer than others. In the great majority of cases a wheel of moderate size revolves on the front roller and drives through a carrier wheel—a large wheel called the "drag" or "gain" wheel. Compounded with this drag wheel is a much smaller wheel, which gears into and drives the back-shaft wheel. Gain is obtained by putting a drag wheel on sufficiently small to make the carriage move more quickly than the yarn is delivered from the rollers. The amount of yarn delivered per stretch is, therefore, determined by the size of the gain wheel. Thus, if 63 inches were given out, with a 95 drag wheel, how many inches would be delivered with a 94 wheel?

$$\frac{94 \times 63}{95} = 62{\cdot}33 \text{ inches.}$$

Figs. 58 and 59 used with the next answer will serve also to illustrate this answer.

Wheel C is on the front roller and drives the carrier wheel, D, and therefore the wheel E. On the same stud as E is the smaller wheel, F, gearing into and driving the wheel G on the back shaft.

Wheel E is the change wheel for "drag" or "gain," and a smaller wheel would cause the carriage to move faster with the rollers at the same speed, and in this way more "gain" would be put in the yarn. The wheels H, I, and the ratchet wheel R, belong to the ratching motion.

Suppose, for instance, 62 inches of cotton were delivered to each spindle in a 64-inch stretch, thus giving 2 inches of gain. The wheel on is a 73, and we put on a 72, how much cotton would then be delivered?

```
73 : 72 : : 62 : ?
     72
     62
    ----
    144
   432
   ----
73)4464(61·15 inches.
   438
   ----
     84
     73
     ----
     110
      73
     ----
      370
      365
```

$64 - 61{\cdot}15 = 2{\cdot}85$ inches gain now put in.

In the case of the "Mendoza"—which is rapidly becoming obsolete on ordinary cotton mules—there is no clutch-box on the back shaft, and the double drag wheel and the carrier are sustained in a weighted lever, which is lifted up out of gear at the termination of the outward run. It is very liable to jump out of gear at the starting out of the mule. Some makers retain the Mendoza idea for safety purposes only, while using the clutch for ordinary disengagement.

Q. 1900. What is a jacking motion? How is it applied and controlled? Why is it used, and what are the dangers (if any) to the yarn arising from its use?

A. A jacking motion is a motion by which the rollers are disconnected, say from zero up to about five inches before the carriage finishes its outward motion. Its object is to improve the quality of the thread by pulling out any thick or snarled, or more softly twisted portions of the threads. During jacking the outward motion of the carriage is finished at a slow rate to prevent the threads from being dragged down, and sometimes for the same purpose the rollers are allowed to deliver a very small portion of yarn by means of the "jacking roller delivery motion". In Dobson's motion the carrier wheel between the front roller wheel and the "drag" or "gain" wheel is coupled up to a supplementary driving from the speed wheel shaft, by which the rotation of the back shaft is continued after the roller-box has been opened.

The motion can be adjusted in about one minute to begin ratching or jacking at any required point in the stretch by simply opening the roller-box at the required moment. If applied too much the ratching motion will pull the threads down.

Ratching Motion.

Referring to Figs. 58 and 59, it must be understood that the parts H, I, P, R are supplementary to those found on

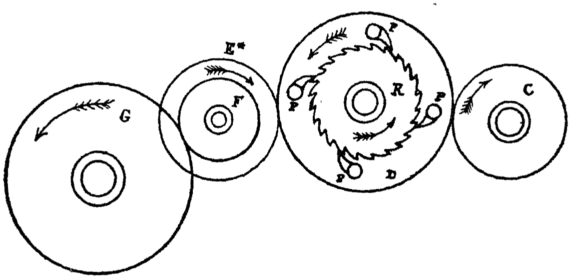


FIG. 58.

most mules, being only used in some mules intended to put in more or less of "jacking". I is a small bevel wheel,

which gives motion to H at about one-fourth or one-fifth its own rate of speed, although the sketch does not show this difference in size between the wheels H, I sufficiently. R is a ratchet wheel carried on same bush or loose boss as bevel wheel, H. P are small pawls or catches carried round by a flange connected to the carrier wheel, D.

It must be understood that during ordinary spinning the slow speed at which the ratchet wheel, R, is rotated enables the small catches, P, to ride harmlessly over the teeth of R, owing to the catches moving round four or five times as quickly as R.

When, however, the roller-box is opened, so as to commence "ratching," the main driving of the wheels, C, D, E, F, G is stopped, and the small catches slow down.

They would stop almost altogether, but then begin to be

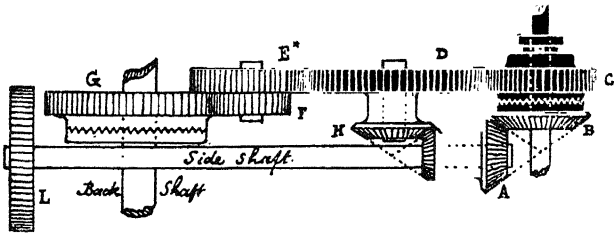


FIG. 59.

taken round at about one-fourth their usual speed by the ratchet wheel, R, impelled by the bevel wheels, H, I.

Very frequently now the small catches, P, are dispensed with, and in their place is used one strong catch, which is engaged and disengaged by a spring, after the manner of the well-known winding spring and click arrangement.

A fault of the small catches is their tendency to get sticky and fast with dirt, and to refuse to engage promptly, as they depend upon their own weight for falling into gear.

Q. For what reason do fine spinners put in most of the twist at the finish of the stretch? Why do some spinners allow the draft rollers to deliver as the yarn is being wound on the spindles?

A. (1) It is seldom indeed that fine spinners do put in most of the twist at the finish of the stretch, a proportion of one-third to two-fifths of the total being something like

the usual limit. Twisting at the head is done principally to allow of the insertion of a larger proportion of "gain" and "ratch" than would be possible without breaking the threads if the twist was all inserted during the outward motion. (2) The principal advantage accruing from the delivery of yarn during the return motion of the carriage is increased production.

Q. 1898. What would be the effect respectively of changing the diameter of the rim pulley or of the twist wheel in a mule if the other remained constant? Which is the most desirable procedure, and why?

A. The effect of changing either the rim pulley or the twist wheel of a mule would be to alter the amount of twist per inch if the other part remained constant. The difference between the alterations would be that by altering the size of rim pulley the revolutions per minute of the spindles would be altered and the carriage speed would remain the same. A larger rim pulley would speed up the spindles. The opposite effect would result from an alteration in the size of twist wheel only, *i.e.*, the spindle speed would remain unchanged while the number of stretches per minute would be varied, and in this way the twist per inch would be altered. On most mules a larger twist wheel would mean more turns per inch, although on some mules the opposite would hold good.

As to which would be the most desirable procedure would depend entirely upon circumstances. For most changes it is probable that it is the preferable method to alter the size of twist wheel, as this maintains the same spindle speed. In addition, it reduces the speed of the carriage for finer numbers, which is usually a very desirable point to secure.

Suppose we were making an extreme change of, say, from 60's to 20's, it would be probably requisite to alter the size of rim, because if the change of twist were all effected at the twist wheel the carriage speed would be impracticably quick, as it would simply jump outwards. In some cases of going two or three hanks finer, the alteration of twist is effected on the rim pulley, because it maintains the same production.

Q. 1897. Describe fully the backing-off in a mule; and say to what extent it varies during the building of a cop.

A. In some older makes of Dobson's Mules the nose of the gun lever comes against a lever pendant at the front of headstock, just before the carriage reaches the holding-out catch. This pendant lever is connected by a long rod to a lever just below the roller beam connected to the backing-off friction, and being moved by the gun lever at once attempts to engage the backing-off friction. Until twisting at the head is finished the only result, however, is that the backing-off spring is charged and the force is resisted by a special stop connected to the fork rod of the down belt. Immediately this stop is removed by the belt going on the loose pulley the backing-off friction is engaged, and at once reverses the rim shaft and tin roller shaft, and consequently the tin rollers and spindles. At the same time the reversal of the tin roller shaft causes the backing-off click and click wheel to engage and to pull the winding-faller round, and therefore the winding-faller wire down, by means of the backing-off chain. It is in connection with this backing-off chain chiefly that we might expect a variation in the action of the backing-off parts to take place. In many new mules the chain would be automatically tightened as the cops got bigger, in order to make compensation for the faller-wire not having to descend so far and to maintain a correct proportion and timing between the descent of the wire and the unwinding of the threads from the spindles. To get good backing-off we ought to be sure that the friction is well set and in good condition and the spring is of correct tension, and, above all, to see that when the friction is engaged all the force is expended in keeping the friction in and not on some obstacle, as we have frequently known to be the case.

In most other makes of mules the shark's jaw method of engaging the friction is in use. The principle is exactly the same, the chief difference being that the long backing-off rod is pushed backwards instead of forwards as described above. There is now in most new mules a disengaging spring, which has for its especial object the effective and prompt disengagement of the friction at the proper time.

Backing-off and Taking-in.

Fig. 60 illustrates the arrangement often applied to Dobson's coarse Mules.

Index of Parts.

B is the large backing-off friction Wheel and Cone.
At C is fulcrumed the short backing-off Lever.
J is a stop to assist in disengaging the friction Cone.
L is a stud on the backing-off Rod, designed to keep the taking-in friction disengaged during backing-off.
At O is the fulcrum of the taking-in friction Lever.
P is the taking-in friction Cone or Dish.
Q is the leather-covered taking-in friction.
R is the bottom drawing-up or Scroll-shaft.
S is the small Bevel which drives T.
T is the large taking-up Shaft Wheel keyed on the Scroll-shaft.
X is drawing-up friction Spring.
V is a supplementary Catch, which is designed to keep the drawing-up friction disengaged during spinning.
S′ is the backing-off Spring.
S″ is the disengaging Spring for backing-off.
n is a finger connected to the locking Lever parts and carried by the carriage square.
p is an adjustable Bracket fastened to backing-off Rod.
q is the fulcrum of the holding-out Catch which holds the carriage at the point *r*.

Action of Parts.

It must be understood that the illustration shows all parts in backing-off position.

The finger, *n*, comes out with the carriage and pushes at the bracket, P, and therefore slides the backing-off rod in the direction shown. This tensions both the springs, S′, S″, and S′ endeavours to engage the friction cone, B, but is prevented by a special stop (not shown) until the down belt is moved on the loose pulley. The movement of the belt allows the engagement of the friction cone, B, and backing-off takes place. At its termination the fallers lock, and the finger, *n*, releases the backing-off rod, when the bottom spring, S″, by means of stud, J, disengages the friction cone, B.

The other parts belong to taking-up.

(See 1915 additions to this Chapter for alternative arrangements).

QUADRANT.

Q. 1896. Describe the action of the winding quadrant in a mule (1) during the run-out of the carriage and (2) during the inward run.

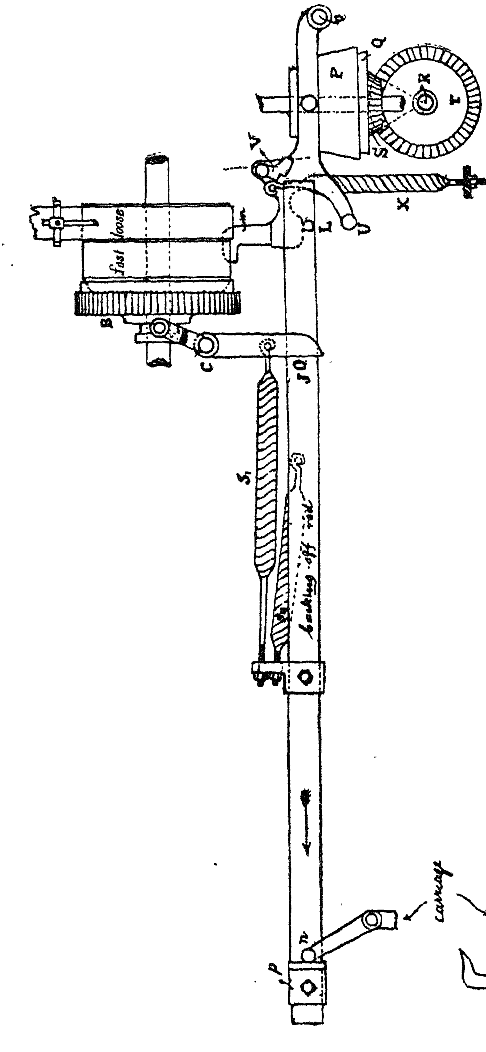


FIG. 60.

A. During the outward run of the carriage the quadrant of a mule is practically inoperative. Of course, it is made to move outwards as the carriage moves out, but its movement has no effect on the revolution of the spindles, which are at that time caused to revolve by the rim band. This movement of the quadrant brings it into position for commencing the inward run. Both the outward and inward run of the carriage are controlled on some mules by a side shaft and bevel wheels, which connect the back shaft and the quadrant shaft together. On most mules the same connection is effected by quadrant bands, to the exclusion of the side shaft. During backing-off the quadrant is stationary. It is during the run in of the carriage that its peculiar and beneficial virtues are brought into action, in such a manner that it may be styled the "differential winding motion of the mule". During the inward movement of the carriage the rim band has nothing to do with the revolution of the spindles and might as well be off. The spindles are caused to revolve in the following manner: The winding chain in being pulled off the winding drum causes the latter to revolve, and the motion is transferred to the tin roller shaft by means of the winding spring, winding click and disc, and winding wheels. The speed at which the tin rollers, and consequently the spindles, are revolved depends upon the celerity with which the chain is pulled from the winding drum, and this latter is controlled by the quadrant. If the end of the winding chain that is attached to the quadrant is moved forward slowly, or none at all, a comparatively quick speed is imported to the spindles. If the same point is moved forward more rapidly a reduction in the revolution of the spindles, and consequently in the winding power, takes place. This peculiar virtue of the quadrant is taken advantage of chiefly in two ways: first, to make compensation in the winding for the ever-increasing diameter of the cop from the bare spindle until the thickness is attained; secondly, to make compensation in the winding during any one run in of the carriage for the different diameters of the cop chase upon which the yarn is put. This second effect only begins to be exercised to the greatest possible advantage after the thickness of the cop has been attained and the conical configuration of the "chase" has become fully developed. During the first few stretches after doffing the second virtue is not exercised

at all, or at the most very slightly, and at this time the first virtue is exercised to its greatest extent. From this point

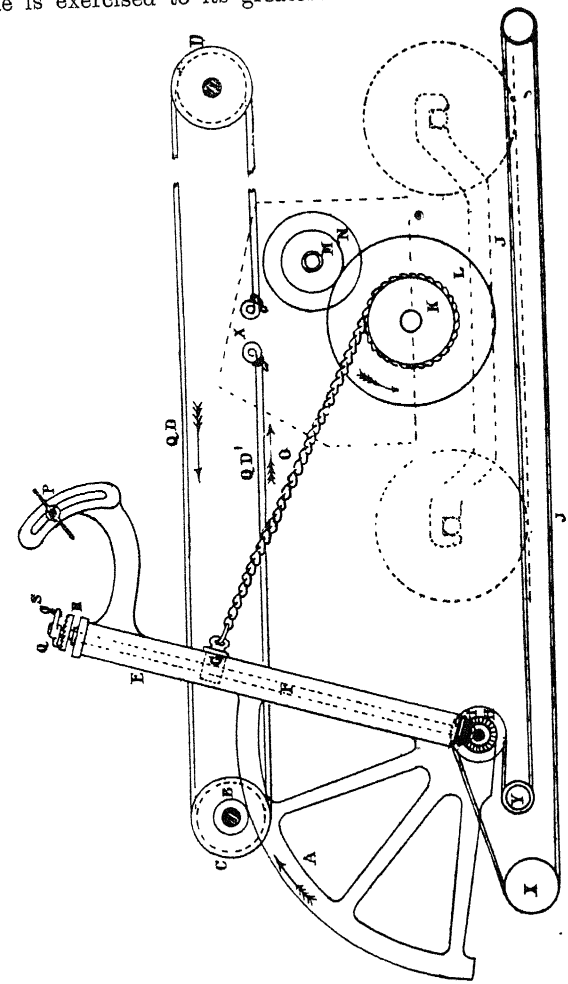


FIG. 61.

until the "thickness" or "body" of the cop is reached both properties are exercised at once, but the first in a gradually

decreasing and the second in a gradually increasing ratio. When the thickness is attained we should be able to turn the "governing motion" handle over until doffing time, but as a matter of fact there are many mules upon which the handle has to be used a little at different times in the formation of the body of the cop. On some mules the motion of the quadrant is utilised for moving the builder-wheel catch. The quadrant has one very serious defect. It cannot make compensation in the winding for the tapered spindle necessarily employed on the mule. This necessitates the employment of "nosing motions," which, however, are invariably connected more or less to the quadrant. The quadrant was invented by Richard Roberts, of Manchester, about the year 1830, and forms one of the most beautiful and useful examples of automatic equation ever invented. Substitutes for it have often been invented, but have never met with much success.

Referring to Fig. 61, A is the quadrant; B is the small wheel which gives motion to the quadrant, being itself operated by the backward and forward motion of the two quadrant bands, Q, D and Q, D^1; C is the front scroll drum upon which the two quadrant bands are alternately wound and unwound, while D is a carrier pulley for the top band. At X the two bands are secured to tightening racks fast in the carriage square, and it is the carriage which pulls the bands backwards and forwards; E is the quadrant arm containing the screw or worm, F, upon which is moved up and down the quadrant nut, G; O is the quadrant chain which winds alternately on and off the winding drum, K; L is the winding-drum wheel which gives motion during winding-on to the wheel, M, forming part of the winding click disc, N. During the outward motion of the carriage the chain, O, is wound round the drum by means of the return band, and during the inward run it is unwound from drum, K, by reason of the latter being carried inward by the carriage at a quicker speed than the quadrant arm, E, can move.

Taking-in.

Q. 1900. Describe and sketch the taking-in motion of a mule, and explain its action.

A. Formerly the taking-in motion was operated from the

loose pulley of the rim shaft, but this practice has almost become obsolete. It is the common practice now to have independent rope-driving from the counter-shaft down to the top side shaft of the headstock. From this cross shaft the backing-off friction, the cam shaft (when used), and the vertical taking-in shafts are all operated. The substitution of rope driving (sometimes belts) for the wheel gearing formerly employed in this connection has led to higher speeds, with less breakages, less noise, and greater certainty of action than formerly obtained.

On the back end of the horizontal or rope-pulley shaft is a bevel wheel, which gears into and drives a bevel wheel on the top of the vertical taking-in shaft. At the lower extremity of the vertical shaft is the drawing-up friction, which, at the completion of backing-off, is engaged so as to rotate the large bevel on the bottom horizontal drawing-up scroll shaft. There are four scrolls on this shaft, two containing the drawing-up cords, one the check band, or front scroll band, and the fourth the steady band. At the completion of the run in the drawing-up friction is disengaged so that the four scrolls are ineffective, although the rope driving is doing its work all the time.

Referring to Fig. 62, A is a three-grooved rope pulley, keyed on the counter-shaft and sustained in the bearing C, which latter is secured to the ceiling; B is a carrier pulley for the cord utilised for tightening the cord by moving the pulley in the slot D; E is the pulley driven round by the down-cord, as shown; F is a bevel wheel on same stud as E, and used to drive G, which is a bevel fixed on the upper extremity of the vertical taking-in shaft. The sole duty of the friction band, F, R, is to rotate the taking-in friction, backing-off friction, and the cam friction. The two latter are operated by a small wheel (not shown) fixed on same side shaft as bevel F. The tightening pulley, D, is more usually fixed on the headstock for greater convenience.

It must be understood the friction band and the friction cones are always revolving while the mule is working, but the frictions are inoperative, except at the proper moments, owing to being disengaged.

At the proper moment, that is, when the fallers lock, the friction dish, P, drops into engagement with the leather-covered friction Q, and, by means of bevel, S, gives motion

to the large bevel T, and therefore to the bottom scroll shaft R, to which T is keyed. The two scrolls, J, H, being connected by cords to the carriage the latter is thereby pulled in.

Check Band.—At I is a scroll round which a band is wrapped the opposite way to those at H and K. This band

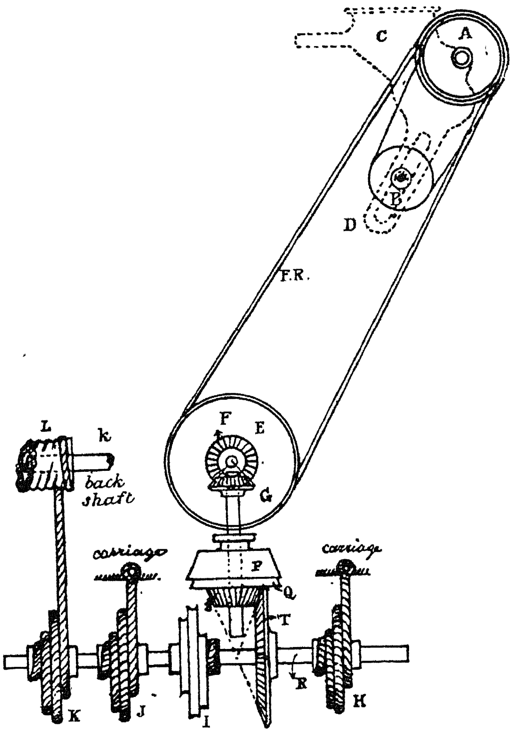


Fig. 62.

is utilised to check the inward motion of the carriage, and exercises a somewhat similar action to that of a brake on a vehicle going down hill. It is of special service in preventing the carriage from bumping heavily against the back-stops. All the cords are secured to adjustable tightening racks.

Steady Band.—The band wrapped round the scroll, K, is

of much more recent application than the others on the same shaft. Its special use is to couple up the scroll shaft with the long back shaft at K, L. In this way the rotation of the bottom scroll shaft gives motion to the back shaft, and the latter assists to pull in the carriage steadily and squarely for its full length.

Q. 1898. Describe the construction of the governing or strapping gear of a mule, and say how it acts.

A. A good governing or "strapping" motion is of great practical value, so much so, that it is quite common for minders, when comparing the relative merits and demerits of various makes of mules, to make special reference to this motion. There is invariably a bevel wheel fitted on the lower extremity of the quadrant worm or spindle, and driven from another bevel in a manner determined by the ever-increasing diameter of the cops. It is well known that the object of the motion is to automatically control the upward motion of the quadrant nut, so as to make compensation in the winding for the ever-increasing diameter of the cops from the bare spindle to the full thickness. In some few cases the motion is operated just as the carriage reaches the termination of its outward movement. It is, however, by far the more common and better plan to operate it during the inward movement of the carriage, the extent of movement to be regulated by the position of the faller, and more especially by the counter-faller. There is a thin cord passing round a pulley on the same stud as the driving bevel wheel before referred to, and extending underneath the carriage, and a guide pulley at the back. Certain thin chains or other equivalent apparatus hang from the faller-wires and support a lever at their lower extremity. When the counter-faller wire rides too low, through the winding being too keen, the lever is dropped sufficiently to cause the "strapping" cord to be taken forward with the carriage, and thus to impart motion to the bevel wheels, and thereby to the quadrant worm and nut. When the ends of yarn are sufficiently slack the cord is not operated. After the thickness of cop is attained, the motion is practically inoperative until after doffing has taken place, because no variation in the diameter of the cops should take place during that time.

Referring to Fig. 61 previously given, J is the governing motion band passing round the guide pulleys X, Y, and

giving motion by means of bevels H, I, to the quadrant screw or worm F. The band is controlled in its motion by a connection from the fallers, and the quadrant nut, G, is thus raised up the arm, E, higher and higher as the cops continue to increase in diameter. By means of the handle S, the screw, F, can be turned either way by hand. R is a rack having a catch, Q, arranged to prevent the screw, F, from moving round the wrong way.

SETTING THE SECTOR.

During the last few years, at our various cotton classes, a good deal of discussion has been devoted to the proper adjustment of the sector. The particular portion of mechanism which is thus familiarly described is the pudding-shaped bracket which connects the locking lever or bootleg to the winding-faller shaft. There can be no doubt that this bracket exercises a greater effect on the shapes of the cops than many of our best practical men have in years gone by fully appreciated. Briefly put, the normal setting of the sector is, or should be, as follows: When the sector stud centre is in a horizontal line with the centre of the winding-faller shaft the winding-faller wire should be in a line which is at right angles to the spindle blade, and passing through the centre of the working length of the spindle blade, and also through the centre of the winding-faller shaft. To maintain these conditions more bevels of spindles would require the faller shafts raising or setting closer to the spindles, and if we were spinning pin cops on twist gauge the fallers should be raised slightly. If the wire is too high when the sector stud is in the proper horizontal line there will be a tendency for the cops to build thicker at the upper half of the cop than at the lower half, while if the wire be too low exactly the opposite effect is produced. It must not be forgotten that sufficiently satisfactory results are often obtained without the setting of the sector being in exact accordance with the above rule. In many cases of spinning pin-cop weft or twist gauge the management will not be at the trouble to alter the sector, although the author is of opinion it would, in many such cases, pay to do so. It must not be forgotten that the sector is only one factor out of several which affect the shapes of

cops, other prominent factors being the copping rails and plates.

Q. 1898. The winding chain of a mule may be either too slack or too tight at the beginning of winding. What would be the effect upon the yarn in each case respectively, assuming you are dealing with a cop after the bottom is fully formed?

A. We have often been troubled with the winding chain being a trifle slack at the commencement of winding, and the evil is that it allows the carriage to start up before winding commences for just an instant, thus allowing the under faller to get too high. We have never seen a case of the chain being too tight at the commencement of winding, although we have often been troubled with its becoming tight before backing-off has taken place, and the winding click and wheel becoming engaged so as to stop backing-off. If the examiner means that the quadrant nut may be too high or too low, then the effect of the nut being too high would be that the yarn would be too slackly wound, and long snarls would be left in the yarn when the fallers unlocked. If the nut were too low, then the yarn would be wound too tightly, and if the nut was much too low a "sawney" would be made.

Q. 1898. What is the nosing motion used on a mule, and why is it needed?

A. The nosing motion on a mule is an apparatus by which the speed of the spindles is accelerated just before the termination of the inward run of the carriage. It is necessary in order to make compensation for the tapered spindle always used on a mule. Most nosing motions accomplish their object by deflecting the winding chain either by pushing or pulling down at it, although in one form the object is attained by using a tapered winding drum. The nosing motion should not begin to act until after the bottom of the cop is fully formed. Most new nosing motions are automatic.

Referring to Fig. 61, previously given, the adjustable stud at P moves downward as the carriage moves inward, and by-and-by depresses the chain O, thus pulling more chain from the winding drum K, and accelerating the spindle speed. By moving more down the slot the stud, P, can be made to deflect the chain, O, more and more as the cops become longer.

Q. 1899. Describe the click motion of a mule. What is

its purpose, and how and at what period does it act? What are the chief defects occurring in it or in the yarn by reason of them? If you are acquainted with any device to overcome the defect give brief description.

A. On some mules there are click motions for the following five different purposes: (1) Winding-on motion; (2) backing-off motion; (3) winding delivery motion; (4) jacking delivery motion; (5) ratching or slow speed motion of carriage. We take this question as applying to the winding-on motion. To the tin roller shaft is keyed a click wheel, over the teeth of which a click is held in position by a plate wheel driven from the winding-on drum. There is a special form of spring employed for the purpose of putting the catch in and out of gear as required. The purpose of the arrangement is to transmit the motion of the winding drum to the tin roller, and therefore to give a suitable revolution to the spindles during winding-on. The defects of the motion are its liability to get into gear at the wrong time, and, greater still, its failure or partial failure of engagement at the proper time. Sometimes it engages during backing-off, quite blocking that operation and stopping the mule. On the other hand, it may miss a few teeth at other times, thus causing the threads to be filled with snarles. Occasionally it may miss entirely or fly out, the result being that all the threads are broken. In the ordinary winding-click arrangement the engagement is effected by the pull of the winding chain when the carriage begins to move inwards. In a well-known improved form there is a lever pendant from the arrangement capable of being acted on from a long rod underneath the carriage. When the fallers lock, and the holding-out catch lifts up a collar, the long rod comes against the tail end of the pendant lever and causes the engagement of the click even before the carriage commences its inward motion, thus guarding against imperfect and irregular engagement of the click. Several improved forms of winding click have been devised at times.

Click Motion.

Referring to Figs. 63 and 64, M is the small winding wheel operated by the winding drum; N is the tin roller;

P is the winding-wheel disc, being compounded with M and carrying the winding click or catch at Q; R is the winding click-wheel; S is the tin-roller shaft, having a boss partially encircled by the shaded or leather-covered portion of the winding spring T.

As the carriage moves inward the unwrapping of the winding chain from the winding drum compels M to move round and to take with it the disc or flange P, and therefore the catch Q. The spring, T, compels the engagement of the

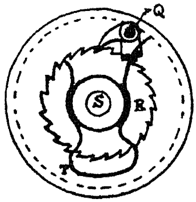


FIG. 63.

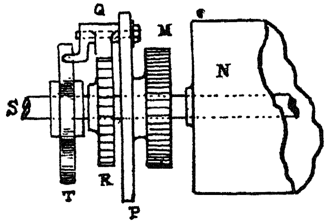


FIG. 64.

catch, Q, with the ratchet or click wheel, R, and thus the latter is suitably rotated. As R is keyed on the tin roller shaft, S, and as the tin rollers drive the spindles, by means of the spindle bands, in this way the proper winding-on speed is given to the spindles.

It will be understood that as previously explained it is the quadrant which causes the suitable revolution of the wheel M.

Counter-Faller Weight.

A question sometimes asked is, "What is the rule for changing the counter-faller weights?"

About 1832 Dr. Ure wrote as follows :—

"The quantity of weight to be applied to the counter-faller will depend on the number of spindles in the mule, the count and description of the yarn, and the degree of hardness of the cop which the yarn will admit of without damage to the quality.

"As a general rule, however, faller-weights may be used as follows :—

"A twist mule for every 100 spindles,	12 to 16 lb.
"A weft ,, ,,	9 to 12 ,,

"Low counts, of course, admit of more weight than fine ones. In cases where the relieving lever weight is introduced, which, while the yarn is backed off and the faller depressed, is caused not to act upon the counter-faller, but when these motions are performed is caused to act upon it during the winding-on of the yarn, the proportion of weight so applied should be from two-fifths to three-sevenths of the total weight acting upon the counter-faller."

It must be distinctly understood that the present author does not commit himself here to any opinion as to the truth, or otherwise, of Dr. Ure's statements as quoted above.

Builder Wheel for New Mules.

The rapid increase of text-books, and the development of study, largely brought about by the influence of cotton classes, have led special attention to be given to any points about which there appear to be any doubts. One of the questions often asked is whether there can be any rule laid down for accurately determining the number of teeth in the builder wheel in starting a new mule.

It is the opinion of the writer that no strictly correct rule can be laid down, but it is possible to lay down rules which may give a wheel sufficiently near the right size to make a practical start with.

An eminent firm of mule makers lay down the following rules in connection with the starting of their new mules :—

"For $1\frac{1}{8}$ in. gauge, pitch 4—wheel equals about $0{\cdot}7 \times$ counts.

"For $1\frac{3}{8}$ in. gauge, pitch 6—wheel equals about equal to counts."

In this connection it will be interesting to quote what Dr. Ure said on this subject about 1832. Dr. Ure wrote: "The number of teeth in the shaper wheel will nearly correspond with the count of the yarn to make a twist cop of $1\frac{1}{4}$ inch diameter, or a weft cop of one inch diameter, care being taken to use the proper copping plates."

"To make a cop of greater diameter use a wheel with a greater number of teeth, and to make one of less diameter use a wheel with a less number of teeth. It may also be observed that in counts of yarn below No. 24 it will be convenient to have a wheel which will admit of two and

sometimes three teeth being taken at once, by which means a more minute increase or decrease in the diameter of the cop may be effected than by one tooth only being taken."

Q. 1899. The winding of one stretch being completed, describe fully what takes place in any one mule with which you are acquainted between that period and the recommencement of spinning.

A. Just before the termination of the inward run the unlocking bracket comes against the locking lever and disconnects it from the copping apparatus, or, in other words, produces unlocking of the fallers. The faller-springs then immediately pull the winding-faller wire up into position above the spindle points. The depression lever pushes the counter-faller wire into position below the spindle points. The down belt is moved from the loose pulley to the fast pulley. The back shaft and roller clutches are engaged so as to put the carriage and rollers into spinning gear again. The drawing-up friction is disengaged and the winding-on click assumes spinning position.

Q. 1901. Describe what takes place between the time when a mule carriage arrives at the end of its outward run and its release after backing-off is completed.

A. (1) Just as the carriage gets fully out the long lever is changed, and the cam-shaft or shell makes half a revolution, *i.e.*, providing it be a cam-shaft mule. The roller-box and back shaft-box are opened, the strap is moved from the fast to the loose pulley, and the backing-off friction is engaged. The holding-out catch assists in keeping the carriage firmly and steadily in position during backing-off, although the principal reason for the quiescence of the carriage is because all the parts which operate it are out of gear at the time.

(2) While the carriage is on the holding-out catch certain levers, rods, and springs are held in operation, by which the backing-off friction is kept in gear, so as to take temporary command of and reverse the rim shaft. The rim band reverses the tin roller shaft, and therefore all the spindles, so as to unwind a portion of yarn from each spindle. The reversal of the tin roller shaft also causes the backing-off click wheel to engage with its click or catch and to pull the disc or plate wheel round, thus winding the backing-off chain upon the snail and pulling the winding-faller wire down. As

this wire moves down its movement releases the counter wire, and the latter lifts upwards so as to hold the threads of yarn in tension.

(3) When backing-off has proceeded far enough the locking lever mounts the copping slide or block, and is pulled inwards by the strong spiral locking spring. The inward movement of the locking lever—or what is termed *locking of the fallers* —is accompanied by several motions as specified below: (1) The holding-out catch lifts up so as to free the carriage; (2) the drawing-up friction is engaged ready to take in the carriage; (3) the backing-off friction is disengaged. During all this time the roller-box and the back shaft clutch-box are kept disengaged and the down belt is kept on the loose pulley. During backing-off and taking-in all parts of the mule are operated by the "rigging" band.[1]

Copping.

Q. 1896. What is the object of the loose front rail applied to the copping rail of the mule? What advantages are obtained from its use?

A. The object of making the front incline of the copping rail loose, and not in one piece with the rest of the rail, as formerly, is to definitely regulate the distance of the winding-

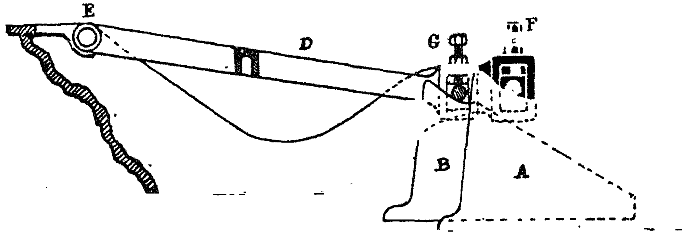


Fig. 65.

faller wire locking below the apex of the "chase" of the cop at all parts of the building of the set of cops. By having a front incline we get a certain amount of yarn wound upon the cop during the downward movement of the winding-faller wire, thus securing a crossing thread which materially strengthens and solidifies the cop, and makes it better for winding-off. It is well known that formerly it was the practice

[1] See also answer to 1913 question given later on in this chapter.

to have the front incline in one piece with the rest part of the rail, the natural consequence being that as the "chase" lengthened, by the back end of the rail falling more rapidly than the front end, the fallers locked with the winding wire at a greater distance below the apex of the cop, and often the ends were broken thereby. The loose front incline now used has separate plates, which are usually shaped very much like the back plates, and which control the fall of the front incline, and consequently the locking of the fallers, independently of the rest part of the rail. By this means it is quite easy to avoid having the fallers to lock at one time too high up, and another time too low down, during the spinning of the same set of cops.

Referring to Fig. 63, A is the front copping plate; B is the loose incline plate or locking plate; D is the loose incline hinged at E to the long incline of the copping rail; F is the vertical screw by which the length of cop chase is regulated; G is the vertical screw by which the depth of faller lock is regulated, a somewhat different method being adopted in some makes of mules.

Q. 1897. What is the object of the quickly descending coils in a mule cop, and how are they laid?

A. The great object of the quickly descending coils in a mule cop is to divide out each stretch of thread to itself so as to get a firmer cop and firmer "chase," and to enable the yarn to come off without entanglement. There are usually three or four of these coils, and they are wound on while the copping wire is descending and the copping bowl is on the loose front incline of the rail. As is well known, it is the modern practice to have this front incline longer than it was formerly, partly in order to give a steadier downward movement to the faller-wire suited to the modern high speeds, but more particularly in order to bury in the chase any snarls which might happen to be on the spindle points. The reason of this front incline being loose is for another purpose, *viz.*, to regulate the locking of the fallers all through the set of cops, so that they shall not be locking much too high at one part and much too low at another part of the set.

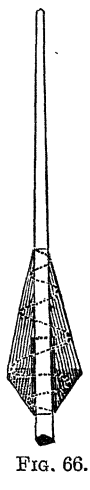


Fig. 66.

The quickly descending crossing or locking coils are shown dotted in Fig. 66 and the manner in which they are laid is described in the previous answer.

Q. 1899. Sketch and describe the shaping motion of a mule, distinguishing clearly the function of each part.

A. In the shaping mechanism there are principally (1) back plate, (2) front plate, (3) middle or loose incline plate, (4) copping rail. The back plate guides the downward motion of the back end of the rail, while the front plate guides the front end and ridge of the rail. The duty of these plates is to so control the motion of the rail as to properly form the two cones of the cop, and afterwards the body or cylinder. The duty of the rail is to guide the winding wire in its movement during each run in, so as to get a proper "chase" on the cop. The great difference in shape between the two plates consists in the initial portion of the back plate being a great deal steeper than that of the front plate, this being essential in order to form the two cones of the cops. The steady bracket is placed between the two plates, and steadies its downward motion, the inclination of this bracket being opposed to that of the plates. The shaper wheel and screw control the movement of the plates so as to build the cops up the spindles. The middle plate controls the motion of the loose incline of the copping rail so as to regulate the depth of faller lock all through the set. The sector and the locking lever come between the copping bowl and the winding faller shaft.

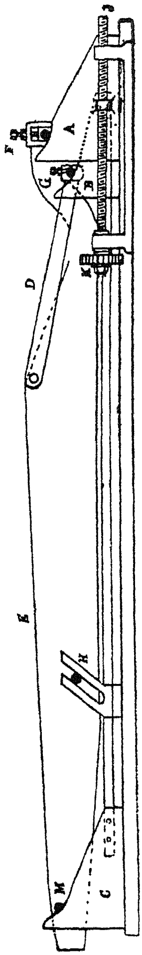


Fig. 67.

Referring to Figs. 65-66, A is the front plate; B is the loose incline plate; C is the back plate; D is the front short loose incline of the copping rail; E is the long incline or principal portion of the copping rail; F is the vertical screw for adjusting length of chase of cop; G

is the screw for adjusting depth of faller lock; H is the steady bracket; at K is the shaper wheel by which the downward motion of the rail is automatically controlled. All the three plates, A, B, C, are coupled up to the shaper screw, and by the slow rotation of the latter the plates are withdrawn from beneath the rail. It may be added that the locking lever and sector are really parts of the copping motion.

Q. 1900. Describe in detail the principle of the construction of a mule cop. Distinguish between the various stages of its formation, and state at what point the various mechanism employed come into operation, describing their functions in brief terms.

A. In the building of a mule cop the very first few layers are disposed in an almost parallel form on the lowest working part of the spindle blade.

After a few stretches the evolution of the top and bottom cones of the cop begins to be seen, and their formation continues until the full thickness of cop and maximum length of both cones are attained, when the bottom cone is quite finished.

Up till this period the coning inclines of the copping plates have been working, and the governing motion has been regulating the winding-on speed of the spindles to suit the continually increasing diameters of the cops. At this stage the above parts cease to act, and the long incline of the front copping plate comes into action, and the body or cylindrical portion of the cop begins to be formed. From this point forward little change takes place in the shape of the cop, except that it continues to grow longer by the steady withdrawal of the copping plates from beneath the copping rail, owing to the action of the builder-wheel motion. A short time after the full thickness of cop is attained the nosing motion usually begins to operate in order to give better noses to the cops, and practically for the same purpose and to save time the backing-off chain may be tightened automatically or manually, as the case may be. The locking or loose incline plates are working during all the time the cops are building, in order to lock the fallers at the required distance below the apices of the cops.

Referring to Fig. 68 at A is shown the cop in its initial stage; at B is shown the cop when the full thickness has

been attained and the two cones of the cop fully formed; at C the cop is almost full, and at D it is shown fully formed. It must be understood that the crossing coils shown dotted at A are closer in practice than shown in the sketch, and the crossing coils at C do not extend down the body of the cop as shown, but always terminate with the depth of top cone being formed at any particular moment.

Q. Name in their proper order the operations required in doffing a mule, taking as an example either paste or tube bottoms, but not both.

A. We will take a mule using tubes :—

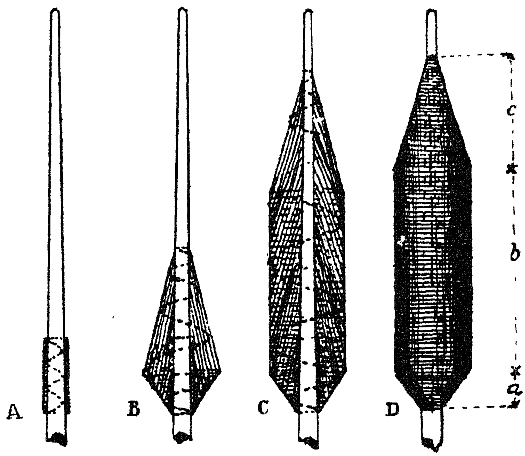


FIG. 68.

(*a*) Stop the mule with the copping rail bowl two or three inches on the inside of the ridge of the rail.

(*b*) Hook or latch the counter-faller wire down, first taking care to have it somewhere near the spindle points in order to have enough, but not too much, slack yarn for doffing.

(*c*) Wind the quadrant nut to the bottom of the arm, or as near thereto as may be required.

(*d*) Return the governing motion chain, the nosing motion, backing-off chain and hastening motions to initial positions.

(*e*) Push up the cops without bending, or leave this until the doffing threads have been wound under.

(*f*) Return the shaper to its initial position, and be careful to have the threads slack enough.

(*g*) Fasten the winding-faller wire under the lowest position of the tubes and wind the doffing or starting threads round the spindles, being careful to have the winding chain tight when the mule is run in.

(*h*) Remove the cops, some spinners first preferring to run the cops over with the hand in order to break the threads.

(*i*) Put on the fresh tubes and push them down to all of equal height on the spindle and in their proper position.

(*j*) Unlatch the fallers, tighten the check band, slacken the threads and run the carriage up.

Q. 1899. Detail the chief differences between a mule spinning 32's and 150's. Why do they exist?

A. The fine spinning mule will probably contain all the parts of the mule for spinning 32's with the following additions:—

(1) Twist motion to put a proportion of the twist in the yarn while the carriage is standing at the head.

(2) "Ratching" motion to allow of the carriage being brought out for the last short portion at a reduced speed.

(3) "Jacking" delivery motion of rollers to give a little yarn from the rollers during ratching and head twisting.

The use of these three motions allows of a good deal of ratch and gain being put into the carriage, so as to draw out any thick places in the yarn and so conduce to greater uniformity of yarn.

(4) Winding roller delivery is optional with the 32's, but invariably used for 150's.

(5) Double speed motions are often employed for 150's, by which the spindle speed during ratching and head twisting is much greater than during ordinary carriage speed. This motion saves time.

(6) A snicking or rim motion would be used probably for the 150's, this being an improved form of the hastening motion which would probably be used for the 32's.

(7) Faller-lifting motions are also often used for 150's, by which the unlocking of the fallers is a great deal more under control than is necessary for 32's. The leather rollers for 32's would have six threads per roller against two threads for the 150's. The finer counts would have much more spindle bevel, finer pointed spindles, and a reduced speed of all parts

of the mule. The 150's would probably also have a special belt arrangement for taking-in, and no taking-in friction, while the rope taking-in and the friction clutch would be used for the 32's. Double roving would be essential for the 150's, while single roving would probably be used for the 32's.

Q. 1897. Is the draft greater or less when fine counts as compared with medium are spun? Give full reasons for your answers.

A. The draft is greater for fine numbers than for medium numbers for one or two reasons. First of all, the length of thread required in a pound of fine yarn is much greater than for medium numbers, and as only the same number of machines are frequently used in which draft is carried out, it is clear that the sum total of draft must be much more for the fine counts, although some of this is obtained by starting with a lighter lap. But this point is greatly accentuated by the fact that fine numbers are invariably spun from a double roving at the mule, whereas it is the usual plan to spin medium numbers from a single roving. Take, for instance, 32's American cotton. It is a common practice to spin them from, say, a 4½ hank roving and a draft of less than eight, whereas 60's Egyptian is usually spun from about ten hank roving double, and almost twelve of a draft. To take another case, six ends are usually put up together at the drawframe for American, with about six of a draft, and although this is also often done for Egyptian, yet in many cases the latter cotton for fine numbers will have eight ends up together at the drawframe, and about eight of a draft. These are only two or three instances going to demonstrate the truth of our assertion that fine numbers require greater drafts than low numbers. It must not be forgotten that chiefly because of this principle there are occasionally four bobbin and fly frames instead of the usual three passages for the very finest numbers, while for very low counts it is sometimes deemed quite sufficient to have only two passages of bobbin and fly frame.

Q. 1897. Suppose you were spinning on a self-acting mule 150's yarn, how would you arrange the mule as to draft, gain and spindle speed, and why?

A. The draft for such numbers would require to be rather high, because of the fine nature of the yarn required, and because double roving would inevitably be employed.

We might fix it at from 13 to 17, according to the hank roving which was being employed and the amount of "ratch" and "gain" being put in.

With respect to the "gain" or "drag," this also could be more or less subject to variation in different concerns. It would probably approximate to about six inches or seven inches for 150's, in addition to the amount of ratch, which might be about three or four inches. This large amount of "ratch" and "gain" is rendered possible by the length of the cotton fibres employed, and because of the fact that a twisting motion would inevitably be employed for these numbers. Only a moderate proportion of the twist would be put in the yarn during spinning and drawing-out, and therefore the yarn would more readily yield to the "gain" than would otherwise be the case. In this connection, also, it must be remembered that a short stretch of, say, about fifty-eight inches or less would be best suited for 150's yard.

As regards the spindle speed, the high speed of 9,000 or 10,000 revolutions per minute, permissible with medium numbers, would not be allowed for 150's on account of the tender nature of the roving. About 6,000 revolutions per minute would be nearer the mark. For these numbers single and double speeds are sometimes employed, in which the twisting speed is much greater than the spinning speed of the spindle. When these are used the price per 1,000 hanks paid to the spinner has to be increased by 5 per cent., and there is the additional drawback that the wear and tear of the rim band and spindle bands is greater. This is supposed to be more than compensated for by the saving of time effected in twisting at the head, obtained by using single and double speed, on the part of the limited number of firms who have the double speed system at work.

Q. 1899. What is meant by "squaring" the carriage of a mule? How is it effected? What happens if a carriage is not square?

A. By "squaring" the carriage of a mule is meant making it parallel with the roller beam. Partly because the mule carriage is moved about by cords, and because of its length, there is a continual tendency for it to get out of square, and it is the duty of the binder to make periodical adjustments. It may be effected as follows: The carriage may be stopped, say, a dozen or so inches away from the

beam, and the distance measured from roller nip to spindle points at the headstock. Then measurements may be made in the middle of each half and at the out ends of the mule, and the carriage bands at these positions adjusted to get the spindles equidistant from the rollers for the full length of the mule. Some prefer to stop the carriage when it is running up, while others like it at a different distance from the roller beam. If alterations in the carriage bands are made to any extent an eye should be kept on the steady band, the under-carriage bands, and sometimes the quadrant, and the back-shaft inclines, and it would be as well to disengage the back-shaft box. If the mule is "out of square" the threads at one point of the length will tend to slacken and snarl, while at the other points they may be napping down. The carriage bands alluded to have been described and sketched previously in this work.

Q. 1899. You are supposed to be working mules with 1,100 spindles each, and a draw of 64 inches, spinning 40's, the number of draws is 3·5 per min. How many hanks should be produced in 10 hours, allowing three-quarters of an hour for stoppages of all kinds?

A. Per mule $= \dfrac{1100 \times 64 \times 3{\cdot}5 \times 60 \times 9{\cdot}25}{12 \times 3 \times 840} = 4522{\cdot}2$ hanks.

From the pair of mules we get $4522{\cdot}2 = 9044{\cdot}4$ hanks.

Q. 1898. A twist wheel is required to spin 40's counts, the twist being 23·72 per inch; the wheel is worked by a worm on the rim shaft; the rim shaft runs at 700 revolutions per minute; the spindle speed is 8,400 revolutions, and the stretch is 64 inches; what size of wheel would you require?

A. 1st method: Because the twist wheel is driven by a single worm on the rim shaft, the number of revolutions per minute of the rim shaft will be equal to the number of teeth moved by the twist wheel in a minute, *viz.*, 700.

In the same time the spindles make 8,400 revolutions.

In one stretch the spindles make $23{\cdot}72 \times 64 = 1518{\cdot}08$ revolutions.

The question may now be re-stated as follows:—

If 8,400 revolutions of spindle require 700 revolutions of the rim shaft, how many revolutions of rim shaft will be

required to give 1,518·08 revolutions of spindle? Clearly less:—

$$8400 : 1518{\cdot}08 :: 700 : ?$$

$$\frac{1518{\cdot}08 \times 700}{8400} = 126{\cdot}5 \text{ teeth};$$

or a 63·28, say a 63 going twice round per stretch.

$$\text{2nd method: } \frac{8400}{700} = 12, \text{ then } 12 \times x = 23{\cdot}72 \times 64,$$

$$\therefore x = \frac{23{\cdot}72 \times 64}{12} = 126{\cdot}5$$

Simple Form. Twisting Motion.

Referring to Fig. 69 all the parts connected more or less with the twisting motion are illustrated. This is the simplest form of twisting motion, and is only one of the various arrangements more or less made for the same purpose.

A is the twist motion lever; B is the large wheel of the backing-off friction; C is the single worm driving the worm wheel D; E is the unlatching or twist motion finger; at F is the stud of the latch lever, A, by which the latter is unlatched from the block stud at R; G is the loose pulley; at H the strap fork engaging spring is coupled up to the strap fork lever, H, F^1, G; S_1 is the disengaging spring of the strap fork lever, or, in other words, the return motion spring; S_{11} is the engaging spring by which the belt is pulled on the loose pulley; B.R. is the long belt rod.

Action of Parts.—As the carriage moves out the stop, N, comes against the lever, L, and moves the latter on the fulcrum, M, so as to engage with the bracket, K, and take the long belt rod forward. The two springs are thus charged, and at once attempt to move the upright rod, H, F^1, G, and the latch lever, A. This, however, cannot be done, owing to lever, A, being latched at R. When, however, sufficient twist has been inserted, the finger, E, of the twist wheel, D, lifts up at the stud, F, and unlatches A from R. Immediately thereafter the spring, S_{11}, impels the belt upon the loose pulley by the connections shown, the latch lever, A, being relatched in its new position. The hastening motion, Q, P,

again unlatches A when the carriage reaches the back stops, and spring, S^1, moves the belt again on the fast pulley.

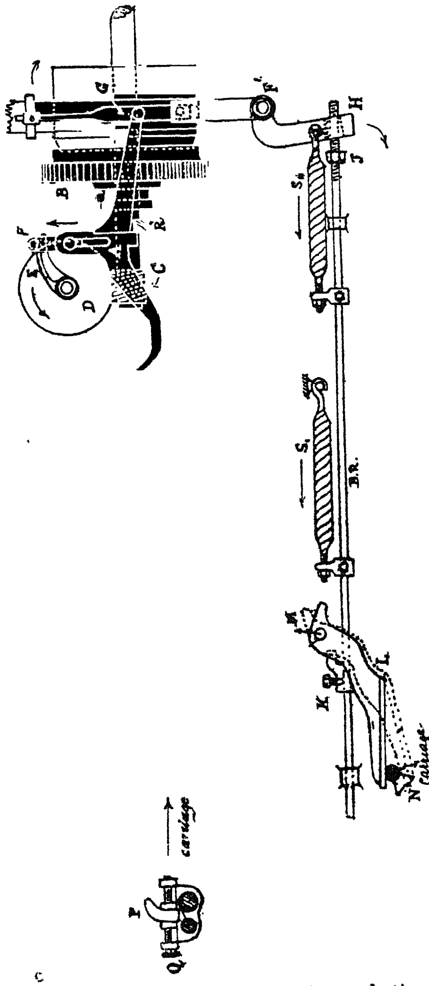


FIG. 69.

Q. 1900. A rim shaft is running 800 revolutions per minute. It drives by a single worm a wheel with 40 teeth,

which is compounded with a pinion with 18 teeth, gearing into a wheel with 60 teeth, on the arbor of which is a crank releasing the belt lever. How many seconds will be consumed in rotating the crank once?

A. (1) Ascertain revolutions per minute made by the crank by a simple speed calculation, as follows :—

$$\frac{800 \times 1 \times 18}{40 \times 60} = 6 \text{ revolutions.}$$

(2) If the crank makes six revolutions in 60 seconds, how many seconds will it take to make one revolution?

$$6 : 1 : : 60 : ?$$

$$\frac{60}{6} = 10 \text{ seconds.}$$

Q. Give the number of turns per inch for 60's twist, 80's weft Egyptian cotton; 32's twist, 60's weft American cotton. Give rules by which you find these results.

A. Rules :—

(1) Egyptian cotton twist takes $\sqrt{\text{counts}} \times 3{\cdot}606$.
" " weft " " $\times 3{\cdot}183$.
American " twist " " $\times 3{\cdot}75$.
" " weft " " $\times 3{\cdot}25$.

(2) The square roots are as follows :—

$$\sqrt{60} = 7{\cdot}745.$$
$$\sqrt{80} = 8{\cdot}944.$$
$$\sqrt{32} = 5{\cdot}656.$$

(3) $7{\cdot}745 \times 3{\cdot}606 = 27{\cdot}92 =$ turns for the 60's twist.
$8{\cdot}944 \times 3{\cdot}183 = 28{\cdot}4 =$ " 80's weft.
$5{\cdot}656 \times 3{\cdot}75 = 21{\cdot}18 =$ " 32's twist.
$7{\cdot}745 \times 3{\cdot}25 = 25{\cdot}17 =$ " 60's weft.

Q. If the counts required to be spun be 40's, the hank roving 5, front roller wheel 20, crown wheel 120, back roller wheel 54, diameter of back roller $\frac{7}{8}$ inch, diameter of front roller 1 inch, what pinion is required?

$$40 \div 5 = 8 \text{ draft.}$$

A.
$$\frac{120 \times 54 \times 8}{20 \times 8 \times 7} = 46{\cdot}28 \text{ pinion.}$$

Locking of the Fallers and Backing-off Chain.

Figs. 70 and 71 indicate the manner of locking the fallers, the fallers being shown locked in Fig. 70. As the carriage comes out it carries the finger, W, which rides upon the incline, Z, secured to the connecting rod, Y, of the copping plates; in this way W works on the fulcrum, X, and tightens the backing-off chain, S, just before the carriage gets out.

When the carriage does get out and the backing-off friction

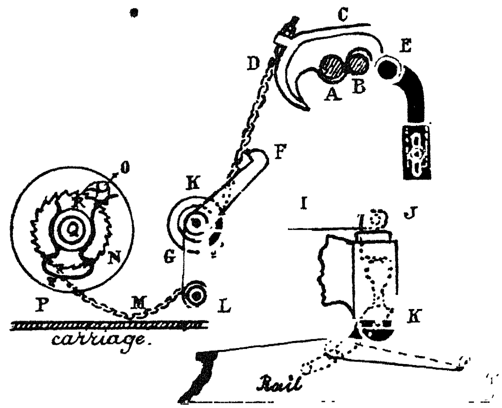


FIG. 70.

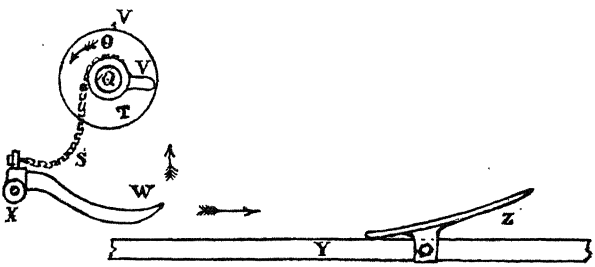


FIG. 71.

is engaged, the rim-band rotates the tin roller shaft, and therefore the ratchet wheel, R, fast on the shaft. Catch, O, is engaged with the ratchet wheel, R, by means of the spring shown. In this way the rotation of the ratchet wheel takes

along the catch, O, and the disc, N, and winds the backing-off chain, M, round the snail. This tightens the chain at M and D, and pulls the sector, C, E, round on the fulcrum, A. The depression of the sector at D, causes the end, E, to lift, and thus to take upwards the locking lever, J. When the locking lever has been lifted sufficiently, a spiral spring (not shown) pulls it upon the dotted slide block at its foot, and in this way the fallers are locked.

The locking of the fallers is accompanied by the slackening of the backing-off chain, the disengagement of the backing-off friction, and the lifting up of the holding-out catch.

Q. A mule winds on the cop 63 inches at one draw, the rim shaft makes 1 revolution for 12 revolutions of the spindle, and I wish to put 20 turns per inch in the yarn, what number of teeth in the twist wheel do I require?

A.

$$\frac{20 \times 63}{12} = 105 \text{ teeth.}$$

Q. If the front roller of a mule be $1\frac{1}{16}$ inch, and the middle $\frac{7}{8}$ inch diameter, being set $\frac{1}{4}$ inch apart, what is the distance from centre to centre?

A. The answer will be half the sum of the diameters of the two rollers, plus the distance between them, thus :—

$$\frac{17}{16} + \frac{14}{16} = \frac{31}{16}'' = \frac{62}{32}''$$

$$\frac{62}{32} \div 2 = \frac{31}{32}''$$

$$\text{and } \frac{31}{32}'' + \frac{1}{4}'' = \frac{31}{32} + \frac{8}{32} = \frac{39}{32} = 1\frac{7}{32} \text{ inch.}$$

Q. How many thousand hanks per week of $56\frac{1}{2}$ hours should be produced by a pair of mules, 108 dozen spindles per mule, making three draws in 40 seconds, allowing $5\frac{1}{2}$ hours per week for cleaning, doffing and breakages, stretch 63 inches, counts spinning 32's?

A.

$$56\tfrac{1}{2} - 5\tfrac{1}{2} = 51 \text{ working hours;}$$

$$108 \times 12 \times 2 = 2{,}592 \text{ total number of spindles;}$$

$$\frac{2592 \times 63 \times 3 \times 60 \times 60 \times 51}{40 \times 12 \times 3 \times 840} = 74{,}358 \text{ hanks.}$$

Q. Yarn wrapping 56's is being spun from a doubled roving, with 40 pinion, each roving being 8 hank. With

what pinion can the same count be spun from a $4\frac{1}{2}$ hank, single roving?

A. Eight hank double equals 4 hank single, so that the change really in effect is from 4 to $4\frac{1}{2}$ hank.

$$\frac{4 \cdot 5 \times 40}{4} = 45 \text{ change pinion required.}$$

Q. 1901. A mule has a rim pulley 18 in. diameter, driving a tin roller pulley 10 in. diameter. The tin roller is 6 in. diameter, and the spindle wharve $\frac{7}{8}$ in. diameter. What is the comparative speed of spindles to that of rim shaft?

A. $$\frac{1 \times 18 \times 6 \times 8}{10 \times 7} =$$

12·342 revolutions of spindle to one of rim shaft.

Q. Find the number of stretches put up in a week, and the price per 100 required to produce a gross wage of £3 9s. 7d. per pair of mules from the following particulars: Number of spindles in one mule, 1,090; from $56\frac{1}{2}$ hours deduct $2\frac{1}{4}$ hours for cleaning and accidental stoppage, and 1 hour and 10 minutes for doffing; speed of each mule 4 draws in 75 seconds. There are 3,185 working minutes.

A. (1) $$\frac{4 \times 60 \times 3185}{75} = 10{,}192 \text{ stretches per mule;}$$

$\therefore$ stretches made by both mules $= 10{,}192 \times 2 = 20{,}384$.

(2) The total wage paid for these stretches = £3 9s. 7d., which reduced = 835 pence.

$$\frac{835 \times 100}{20{,}384} = 4 \cdot 09 \text{ pence per 100 draws.}$$

Q. Taking the stretches as ascertained by the previous question to be $64\frac{1}{2}$ inches long, how many hanks would the week's production amount to, and what price per 1,000 hanks would be required to bring out the wages previously given?

A. (1) $$\frac{\underset{\text{Stretches.}}{20{,}384} \times \underset{\text{Inches.}}{64 \cdot 5} \times \underset{\text{Spindles.}}{2180}}{\underset{\text{Inches per yard.}}{36} \times \underset{\text{Yards per hank.}}{840}} = 94{,}781 \text{ total hanks.}$$

(2) If 835 pence are the wages for 94,781 hanks, what are the wages for 1,000 hanks?

$$\frac{835 \times 1000}{94{,}781} = 8{\cdot}809 \text{ pence per 1000 hanks.}$$

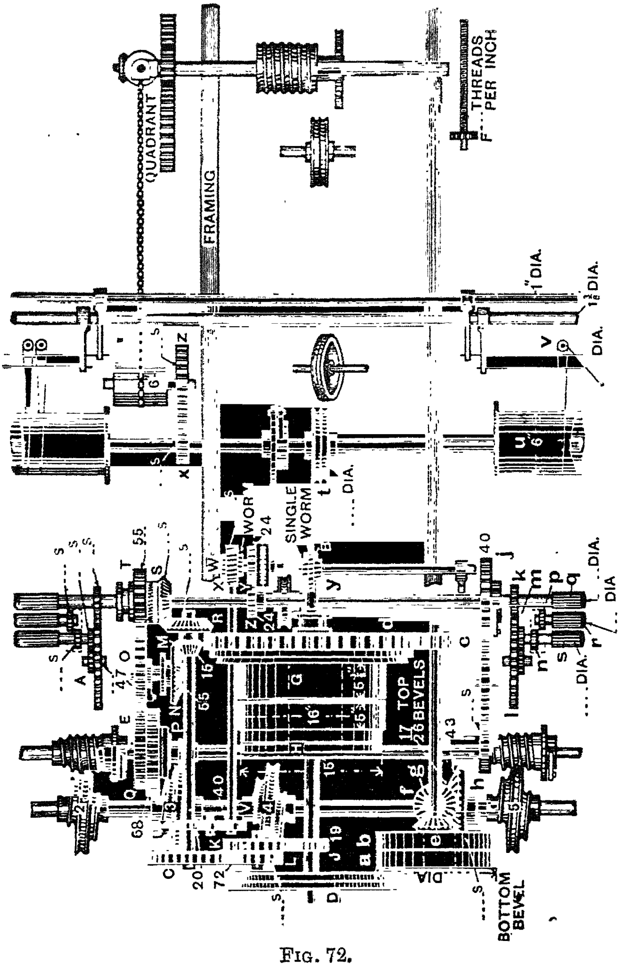


FIG. 72.

Dobson and Barlow's Fine Mule.

References to Gearing Plan of S. A. Mule for Fine Numbers.

A* Draft Wheel.
B* Twist Wheel.
C* Back Change Wheel.
D* Rim Pulley.
E* Gain Wheel.
F* Shaper Wheel.
G Fast Rim Shaft Pulley with leather Cone.
H Fast and Loose Pulley for winding motion.
J Rim Shaft Spur Wheel.
K, L Compound Carrier.
M Side Shaft Bevel for jacking motion.
N Bevel and Catch Wheel for jacking motion.
O Carrier Catch Wheel for jacking motion.
P Gain Pinion.
Q Back Shaft Spur Wheel and Catch Box.
R Side Shaft Bevel.
S Long Boss Bevel and Catch Wheel.
T Roller Gear Catch Box.
U Spur for turning motion.
V Turning motion Shaft Wheel.
W Roller turning motion Worm.
X Roller turning motion Worm Wheel.
Y Roller turning motion Spur Wheel and Catch Plate.
Z Roller turning motion coupling piece Wheel.

a Fast Pulley for driving backing-off.
b Loose Pulley for driving drawing-up.
c Backing-off Pinion.
d Backing-off Cone Wheel.
e Bevel for drawing-up.
f Top Bevel for upright Drawing-up Shaft.
g Bottom Bevel for upright Drawing-up Shaft.
h Scroll Shaft Bevel.
i Spur on Back Shaft. } Roller turning motion whilst winding
j Click and Spur Wheel. } Roller turning motion whilst winding
k Double Front Roller Wheel.
l Top Carrier Wheel.
m Back Roller Wheel.
n Back Roller Wheel driving Middle Roller.
p Middle Roller Wheel.
q Front Roller.
r Middle Roller.
s Back Roller.
t Tin Roller Pulley.
u Tin Roller.
v Spindles.
w Twist Frame Wheels.
x Tin Roller Wheel.
y Twist Worm.
z Winding Drum Wheel.
2 Scroll for Back Shaft.
3 Drawing-up Scroll.
4 Check Scroll.
5 Drawing-up Scroll.
6 Winding drum.

Change Places.

A*	Change place for Draft	. . . . . .	30 to 70 teeth
B*	,, Twist	. . . . . .	40 ,, 120 ,,
C*	,, Drawing-out	. . . . .	60 ,, 119 ,,
D*	,, Speed of Spindles	. . . .	9 ,, 21 ,,
E*	,, Gain and Stretch	. . . .	70 ,, 78 ,,
P*	,, ,,	. . . .	16 ,, 20 ,,
F*	,, Shaper	. . . . . .	12 ,, 70 ,,

Q. 36's twist is being spun with 45 pinion, 18 inch rim, 50 speed wheel, and 36 builder wheel. What wheels will be required for 42's twist from the same roving, a 19 inch rim to be used?

A. (1) $$\frac{45 \times 36}{42} = 38{\cdot}58 \text{ change pinion.}$$

(2) $$\frac{\sqrt{42\text{'s}} \times 50}{\sqrt{36\text{'s}}} = \frac{6{\cdot}48 \times 50}{6} = 54.$$

This 54 would be the driven speed wheel required providing the rim pulley was not changed.

$$\frac{54 \times 18}{19} = 51{\cdot}16, \text{ say } 51.$$

Speed wheel really to be put on.

(3) $$\frac{\sqrt{42} \times 36}{\sqrt{36}} = \frac{6{\cdot}48 \times 36}{6} = 38{\cdot}88 \text{ builder wheel.}$$

Note.—The proper size of builder wheel is affected by the amount of weight on the counter-faller; the length of cop chase; the tightness of winding-on generally; the diameter of bare spindle on the mule or empty bobbin on the ring frame; the pitch of shaper screw; the amount of inclination or vertical fall per inch of length in the copping plates. The above calculation is worked by the rule most adopted, but some people prefer to work by simple proportion.

The author has given very careful consideration to this problem and made many experiments, as it is a matter of some practical importance; and begs to suggest the following *original rule* as being the one most likely to give accurate working results:—

(1) Ascertain the answer by the square root method.
(2) Ascertain the answer given by simple proportion.
(3) Take the mean of these two answers for the final answer.

(1) 38·88 was obtained by the use of square root.

(2) $$\frac{36 \times 42}{36} = 42.$$

(3)
$$\begin{array}{r} 42{\cdot}00 \\ 38{\cdot}88 \\ \hline 2\,)\,80{\cdot}88 \\ \hline 40{\cdot}44 \end{array}$$

Say 40 or 41 wheel required. As this is a small change the difference is not much, but in a large change of counts there may be a very practical difference.

Q. A lever for weighting mule rollers has the last weight notch $5\frac{1}{2}$ inches from the centre of the hole through which the weight wire passes. The centre of this hole is also ·5 inch from the fulcrum end of the lever. The weight applied is $3\frac{1}{2}$ lb. Ascertain the weight on the front saddle.

A.
$$\frac{(5\frac{1}{2} + \frac{1}{2}) \times 3\frac{1}{2}}{\frac{1}{2}} = \frac{6 \times 3{\cdot}5}{{\cdot}5} = 42 \text{ lb.}$$

Q. 1897. The driving pulleys in a mule headstock are 18 inches diameter, and it is desired to run them at 800 revolutions per minute. The line shaft runs at 150 revolutions per minute, and has a driving pulley on it 24 inches diameter. At what speed would you drive the counter shaft, and what diameter of pulleys would you fix on it?

A. Three terms are unknown, *viz.* :—

(*a*) Driven pulley on counter shaft.
(*b*) Driving ,, ,, ,,
(*c*) Speed of ,, ,, ,,

If any of these three particulars be assumed, it will be easy to find the others by calculation. For the benefit of readers we will solve the problem in all three different ways, although only one method is required by the question.

(*a*) A common size of driven pulley on counter shaft is 16 inches, which dimension we will take.

∴ Speed of counter shaft =

$$\frac{150 \times 24}{16} = 225,$$

and driving pulley on counter shaft =

$$\frac{800 \times 18}{225} = 64 \text{ inches.}$$

(*b*) A common size of driving pulley on counter shaft is 28 inches.

∴ Speed of counter shaft would be

$$\frac{800 \times 18}{28} = 514{\cdot}28,$$

and driven pulley on counter shaft would be

$$\frac{150 \times 24}{514 \cdot 28} = 7 \text{ inches.}$$

(*c*) A common speed of counter shaft for the rim to make 800 revolutions is 480 per minute, which we will assume. Therefore the diameter of driven pulley on counter shaft would be

$$\frac{150 \times 24}{480} = 7\tfrac{1}{2} \text{ inches.}$$

and diameter of driving pulley on counter shaft would be

$$\frac{800 \times 18}{480} = 30.$$

It will be noticed that in each of these solutions we get an impracticable dimension, but this is because the assumed speed of line shaft is much too low for actual practice, 260 to 310 revolutions per minute, or more, being nearer the mark. Also the pulley on line shaft is seldom less than about 30 in. diameter for such a speed of rim shaft. Granting that local circumstances compel us to have the particulars given in the question, it would probably be the best plan to put on the counter shaft a driving pulley as large as possible, to enable us to keep the size of driven pulley up, and so minimise the slippage of belts.

We will assume driving pulley on counter shaft to be 44 inches. Therefore speed of counter shaft will be

$$\frac{800 \times 18}{44} = 327 \cdot 27 \text{ revolutions per minute,}$$

and pulley on counter shaft will be

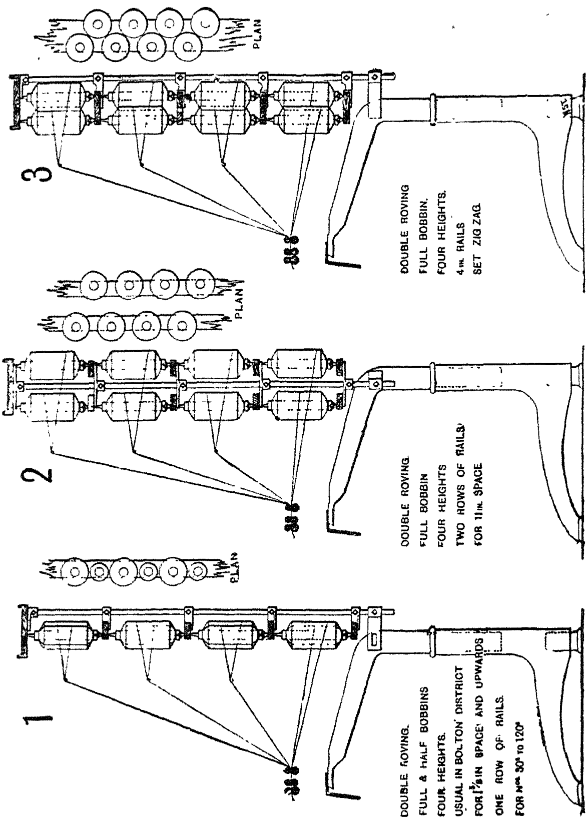
$$\frac{150 \times 24}{327 \cdot 27} = 11 \text{ inches.}$$

Mule Creels.

In Figs. 73 and 74 are shown views of various arrangements of mule creels, with explanations to each view.

Brakes for Mules.

It is well understood that many of the principal difficulties connected with the practical operation of the self-actor mule arise from the necessity of having to reverse the various parts from spinning to winding-on position and *vice versa.* Of

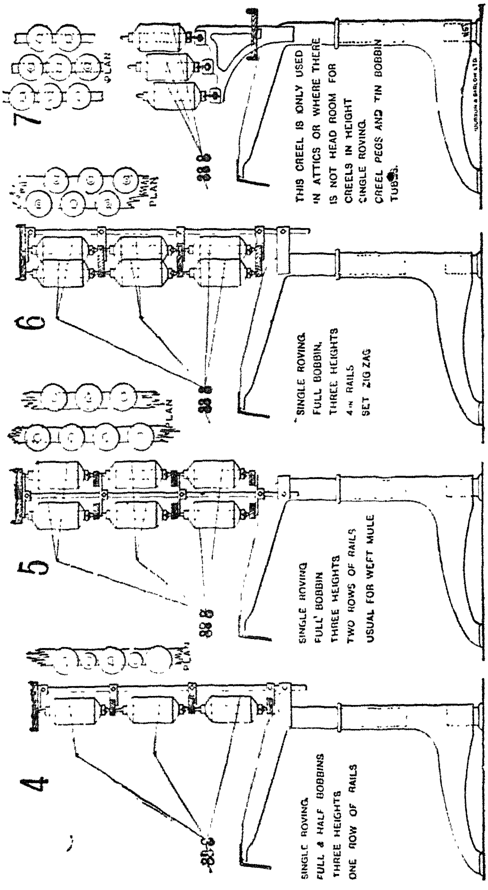


BOBBIN CREELS FOR S. A. MULES

Fig. 73.

these difficulties, one of the greatest consists in providing means for quickly and properly bringing the rim shaft, tin roller shaft, and spindles to a momentary standstill at the

termination of twisting before backing-off can be commenced. It certainly is not the mere act and fact of backing-off pure and simple that imposes most work on the backing-off



BOBBIN CREELS FOR S. A. MULES

FIG. 74.

friction; rather is it the duty of first arresting the spinning revolution of the parts above specified. One of the most frequent causes of serious mill fires during recent years has been the heating of the backing-off friction, largely due to its

having to act as a brake on the rim shaft. Many attempts have been made to provide assistance in this respect by extra brakes. In the Threlfall fine spinning mule fitted with the double rim-pulley system of obtaining single and double speed, the great length of the rim shaft has enabled the makers to easily fit to it a somewhat neat arrangement of brake friction in addition to the ordinary backing-off friction.

The well-known firm of John Hetherington & Co., Manchester, make an ingenious arrangement which acts on the tin roller shaft, and is known as Wain's brake. The broad principle of action and the objects aimed at by the brakes above enumerated are, as stated, to bring the rim shaft, tin roller shaft and spindles quickly and effectively to a standstill without imposing too much strain and work upon the ordinary backing-off friction. For one reason or another these supplementary brakes—although good in principle and object—do not appear to have met with much acceptance by the trade. There have been, however, some cases of their successful application.

Backing-off Brake.

It is a somewhat surprising matter of fact that very little attention has been bestowed by practical men upon the utility of applying a brake to assist in bringing the operation of backing-off itself to a prompter and more definite termination than is customary. Although the revolutions of the spindles, tin rollers, and rim shaft are very low during backing-off, yet they are sufficiently high to cause in some cases a little difficulty to be experienced in bringing them to a quick finish, ready for the quadrant chain and attendant mechanism taking command of the spindles during winding-on. On many mules any evil effects resulting from the want of a brake in this connection are scarcely perceptible. On the other hand, there have been two or three developments in self-acting mules during recent years which have shown up the need of a brake in some cases rather strongly.

On mules fitted with the common or ordinary winding click arrangement, it is well known that the click and click wheel do not engage before the carriage actually begins to move inwards, and in such cases it may fairly be presumed that there is usually little momentum left in the tin roller

shaft, etc. In medium and low counts, however, such high speeds of backing-off are in some cases attained that it is a little doubtful whether even with the ordinary winding click there may not be a little momentum left in the parts specified.

The evil, however, shows up most strongly in the case of click-locking arrangements in which the click and click wheel are engaged before the carriage begins to move inward. More damage may result from this premature engagement than may be at first evident to the casual observer.

In some cases, for instance, the winding catch is engaged by the same rods and levers as are concerned with the lifting up of the holding-out catch and the engagement of the drawing-up friction. The object of this quick engagement is, of course, to ensure that winding-on shall commence promptly and simultaneously with the commencement of each run-in of the carriage, this being a commendable object very well attained by the click-locking motion under discussion.

When, however, this motion is considered in relation to the momentum and opposite revolution set up in the tin roller shaft by the rim band, a practical man will be able to perceive that premature engagement of the winding click will cause a strain to devolve upon the winding chain, winding catch and other related parts, due to the catch having to sustain the shock of at once arresting the stored-up motion in the rim band, tin roller shaft, and other parts connected to that set of mechanical parts.

It will be remembered that the teeth of the winding catch wheel are revolving opposite to the inclination of the winding catch during backing-off, and, realising this, a tyro can see that if the click is engaged while there is still some of this opposite motion in the click wheel, there will be a strain thrown upon some of the parts. In extreme cases it is barely possible that even the free locking of the faller might be somewhat interfered with.

The principal defect lies in the fact that a considerable strain devolves upon the mechanical parts more or less connected with winding-on, owing to these parts having, as it were, to arrest the momentum set up on the tin roller shaft, etc., by the rim band during backing-off. Our remarks have here been mostly confined to showing up certain defects, more especially inherent to those click locking motions in which the same rods and levers that lift the holding-out

catch also engage the winding catch. To some extent the same remarks must perforce apply to those motions which are engaged by the locking of the fallers.

The writer is acquainted with one motion that directly aims at more promptly bringing the tin roller shaft to a standstill at the termination of backing-off.

The invention essentially consists in retarding the movement of the rim band, etc., by a brake or drag. One form of brake suitable for the purpose consists of a disc and click wheel identified with the backing-off mechanism (preferably the tin roller shaft) and a brake block or shoe, carried by a lever under the abutment of an incline or stop on the floor or mule frame when backing-off takes place, adapted to act against the said disc and retard the backing-off to an extent equal to the friction of the brake. Although the brake is acting against the disc during all the time of backing-off, the resistance of the brake is so slight that it does not appreciably affect the work of the backing-off friction. At the same time when the power is taken from the rim shaft and tin roller shaft by the disengagement of the backing-off friction, the patent brake is of sufficient power to substantially aid in bringing the various parts to a standstill, thus easing the initial work of the winding-on parts.

Sunk Slips.

This is an invention by which the slips that the carriage wheels of a mule ride upon are sunk so as to have their working surfaces on a level with the floor. The object is to provide greater freedom for the operatives in the jenny-gate, and to prevent the numerous mishaps to operatives by kicking against and tripping over the present raised slips.

Writing in 1915, after a dozen years' trial, these sunk slips have only met with a moderate amount of adoption. The same remark applies to the backing-off brake.

"Questions and Answers Added in 1915 Revision."

Q. 1914. Describe in detail how the operation of spinning is performed by a mule during the outward movement of the carriage. State which portions of the machine are in operation during this period,

describing the functions of each, and their effect upon the spinning process.

A. The yarn is actually spun during the outward movement of the carriage, and is wound upon the spindle during the run-in. Spinning implies drawing the cotton sufficiently fine and thin, and also putting the twist into the cotton. As the carriage moves outwards the rollers draft or draw out the cotton, the spindles put the twist in, and the carriage movement keeps the cotton sufficiently tight. Rollers, carriage and spindles are all driven from the rim shaft during spinning; the rollers entirely by wheels, the carriage by a combination of wheels and ropes, and the spindles entirely by means of bands. There are three lines of rollers, of which the front roller receives motion from the rim shaft, while the back and middle rollers receive their driving from the front roller. The spindle points are inclined towards the rollers, and are placed in a somewhat lower horizontal plane than the rollers, with the effect that the threads will twist freely over the tops of the spindles. The speed of the carriage is fixed to keep the threads at a sufficient tension without unduly breaking them. Provision is made in the gearing for easily altering the amount of twist, the amount of drag or yarn tension, and the amount of roller draft.

Q. 1914. State the functions of the counter faller wire of a mule, and describe its effect upon the yarn during winding. Describe how the action of this faller wire indicates the existence of imperfect winding tension during the inward movement of the carriage.

A. The duties of the counter faller wire are to take up the slack yarn unwound from the spindles during backing-off, to keep the yarn under tension, and prevent snarls during running in, and to put sufficient drag or tension upon the threads during winding-on, so as to make the cops sufficiently hard. The counter faller wire is out of action as the carriage moves out, is brought into action by the plunge weights during backing-off, and held by these weights against the underside of the threads until the fallers unlock at the finish of the run-in of carriage. If cops are too soft one of the first things to be done is usually to put more weight on the plunge weights or salmon head levers, so that these weights shall hold the wire more strongly against the thread. If

the winding-on is erratic or irregular, *i.e.*, too tight or too slack at any portion of the run-in, the counter wire promptly indicates the error by moving downwards for extra tight threads, and upwards for slack threads. In the same way if the minder or overlooker notices the counter wire to be too low at the finish of the run-in he knows the threads are liable to be cut or broken due to insufficient yarn being left for wrapping round the spindle blade. *Per contra* a high wire near the close of the run-in of carriage indicates insufficient winding, and results in slack and snarly yarn when the fallers unlock.

Q. 1914. It is common practice when drawing rovings in the rollers of spinning machines fitted with self-weighted top rollers to set the drawing rollers a shorter distance apart than the length of fibre being worked. Give full reasons for this procedure, stating class of work for which it is most suitable, and the advantages derived from it.

A. The particular custom alluded to in the question is the usual one in the case of fine spinning mules working Egyptian or Sea Island cotton, and it differs from the usual method adopted for American cotton in which lever-weighted rollers are used and in which it is customary to set the centres of the rollers a distance apart somewhat exceeding the length of cotton fibre.

For example, the total roller draft of a mule spinning 80's to 100's counts of yarn is much greater than that of a mule spinning 20's to 30's from American cotton, because in the first place the finer counts naturally demand more draft, and in the second case still more because double roving is used for the fine counts and only single roving for the coarser counts.

For example, for 28's American cotton we might have a hank roving of four, and a total roller draft of seven. For 90's we might have a hank roving of 14 and a total roller draft of about 11 to 12, leaving a little for carriage draft. The large amount of draft operating upon an already thin roving, separates the fibres so much they tend to fall out or to make middle iron roller laps, and to stop this the centres of front and middle rollers are set a less distance apart than the length of fibre. To prevent the close setting from breaking the cotton fibres the top, middle, and back rollers are self-weighted, and the middle roller is very light.

Methods of Weighting the Top Rollers of Mule.

Fig. 75 shows the usual method for all mules excepting those for fine spinning, for which latter the method shown in Fig. 76 is customary.

In Fig. 75 the weight of 4 or 5 lb. is used with the lever *a* to give a total weight of perhaps 40 to 50 lb. through the medium of the link wires *b c* to the top saddle *d*.

By means of this top saddle *d* the total weight is divided

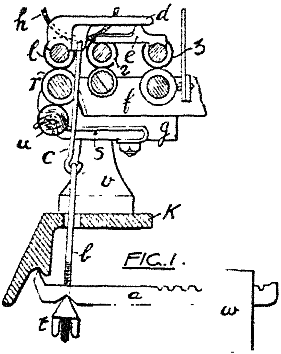


Fig. 75.

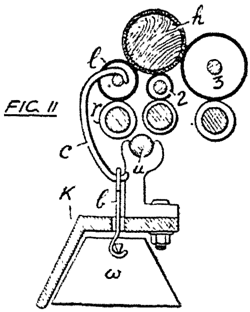


Fig. 76.

between the front roller *c* and the little saddle *e*. The little saddle divides its portion between the middle roller 2 and the back roller 3, so that the back roller receives about double the amount of weight put on the middle roller; *k* represents the roller beam, *u* the "crow" or bottom clearer, *h* the top clearer which serves for one set of rollers, *r* is the bottom front steel roller. One such arrangement serves usually for 6 threads, or 3 threads per boss of the double boss roller in common use; *s* is the spring for holding up the bottom clearer. All three lines of top rollers are definitely and positively weighted, and out of a total of say 48 lb. we might have approximately 32 lb. front roller, 11 lb. on back roller and 5 lb. on middle roller.

Fig. 76 represents the dead-weighting method for the top rollers in general use for fine spinning mules and almost

universally adopted in the Bolton district, whereas in the Oldham district method I is in general use.

During recent years the dead-weighting method has been largely applied in the Oldham, Ashton Shaw, Royton, and Middleton districts in mills put up to spin what are known as Bolton fine counts. Many of the operatives in these districts have found it awkward to piece broken threads on account of the hook *c* being in the way. In many such cases the weight hook has been altered in shape and has been placed between the front and middle top rollers so that it shall permit the Oldham method of piecing up and shall permit the use of crows or flannel covered underclearers. A great objection to this system is the accumulation of fly upon the inside hooks, and the tendency for this fly to make bad ends.

In Fig. 76 *a* is the long fluker rod or underclearer, *h* the long top clearer, *k* the roller beam, *w* the weight of about 5 lb. Whereas with method I one arrangement serves usually for 6 threads, in method II one weight only serves for 2 threads since each top roller has 2 short bosses with 1 thread per boss. The short top middle roller No. 2 is very light and is only self-weighted to permit centres of front and middle rollers being set a shorter distance apart than length of cotton fibre without breaking the fibre. The back top roller No. 3 is also self-weighted.

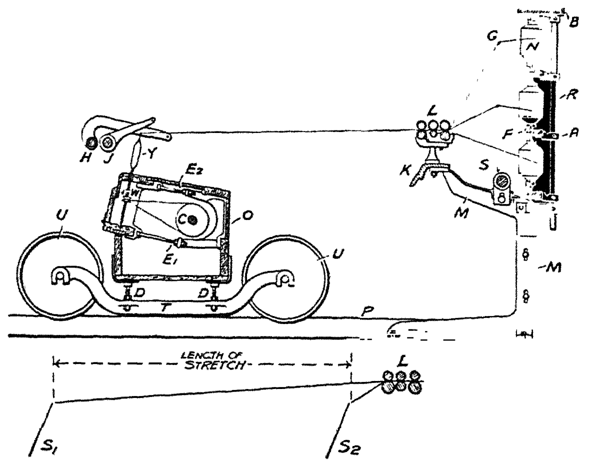
Q. 1910. During the building of a mule cop, what means are employed to counteract the effect of the tapering of the spindles on (*a*) the winding-on, and (*b*) the parallel build of the body of the cop body? 25 marks.

A. (*a*) The nosing motion is specially used to compensate in the winding-on for the employment of a tapered spindle. By means of the nosing motion the spindles are increased in speed during the last short portion of the inward run of carriage, so that increased speed is given in proportion to the thinner spindle, and the acceleration of spindle speed becomes greater just as more of the thinner portion of spindle is used. Nosing motions are of various types, but may be broadly divided into (*a*) those which draw more chain from the winding drum, and (*b*) those in which a tapered winding drum is used. The nose peg is simply an adjustable stud carried in a long slotted arm affixed to the quadrant

arm, and this stud is brought down on the winding chain as the carriage moves in, so that the chain is deflected. (*b*) Very often the back copping rail plate is made rather less steep than the front plate in the lower half of the long incline of plate, and this shortens the length of cop chase or top cone, so that the same amount of yarn is spread over a shorter length of top cone with a consequent increase of thickness of cop due to this source. This naturally counteracts the thinning effect on the cop of using a tapered spindle, and the effect is slightly aided by the short forward movement of copping rail due to the use of an inclined steady bracket.

Passage of Cotton.

The single creel in Fig. 77 with single row of bobbins NF and three rows in height serves well for twist yarns spun from



Figs. 77 and 77a.

single roving. The rods RB are connected to the samsons or spring pieces M and sustain the creel boards in a suitable manner. Guide rods G are used for the rovings from the top and middle rows of bobbins. At S is the long back shaft. Each roving passes through the three lines of top

and bottom rollers L and is drafted to the required counts of yarn by these rollers.

K is the roller beam supported by the spring pieces M.

At H we have the counter faller shaft, at J the winding faller shaft, and at Y the cop of spun yarn, E1 and E2 represent. the carriage rods for holding the top and bottom spindle rails in a manner which permits adjustment of spindle bevel. At C is the tin roller, U, U represent the carriage bowls, T the carriage bearer, and P the slip or carriage rail.

DD represents the vertical rising screws which sustain the carriage in a manner which permits of adjusting the spindle points for height in relation to the rollers.

The small supplementary sketch shows the relative positions of spindle point and rollers for extreme positions of the carriage. S_1 and S_2 represent the spindle in two positions.

Q. 1909. Sketch and describe the strap-relieving motion of the mule, stating its advantages and disadvantages. For what counts and qualities of yarn is it generally used, and why?

A. By means of the strap-relieving motion, or drawing-off motion, the down belt of a self-acting mule may be moved either partially or entirely from fast to loose pulley before the carriage gets fully out and before the cam-shaft changes. The motion is usually applied to mules in which there is no supplementary twisting motion and no ratch, and is therefore almost universally in use on mules using American cotton rovings and high speed mules generally.

During recent years a good many mules which put in supplementary twist have had mechanism applied by which the belt is drawn about half-way from fast to loose pulley on the relieving motion principle, the other half movement occurring at the completion of twisting. The strap-relieving motion has proved to be a very successful device.

The advantages sought by the use of the strap-relieving motion are, quicker backing-off owing to the twisting momentum of rim shaft and spindles being more easily arrested; less danger of fire, and less wear of backing-off friction owing to this friction having less breaking work to do; and steadier finish to the outward carriage travel.

A disadvantage possibly attendant on its over-application is the mule stopping out when the engine is running slowly.

The same thing that checks the carriage momentum also checks the twisting action. Abrupt backing-off is not beneficial to the life of the rim-band.

Messrs. Asa Lees' well-known and successful arrangement is sketched and explained below.

Strap Relieving and Locking Motions (Fig. 78).

In Fig. 78 the object of this motion is to move the strap from the fast to the loose pulley when the carriage is within 2 inches to 12 inches of the completion of the outward run, the momentum of the carriage at this stage being sufficient to complete the outward run.

The locking arrangement connected to this motion enables the minder to stop the mule without moving the top driving belt on to the loose pulley, which permits him to clean and oil the loose pulley without removing the belt and without any fear of the mule being accidentally started.

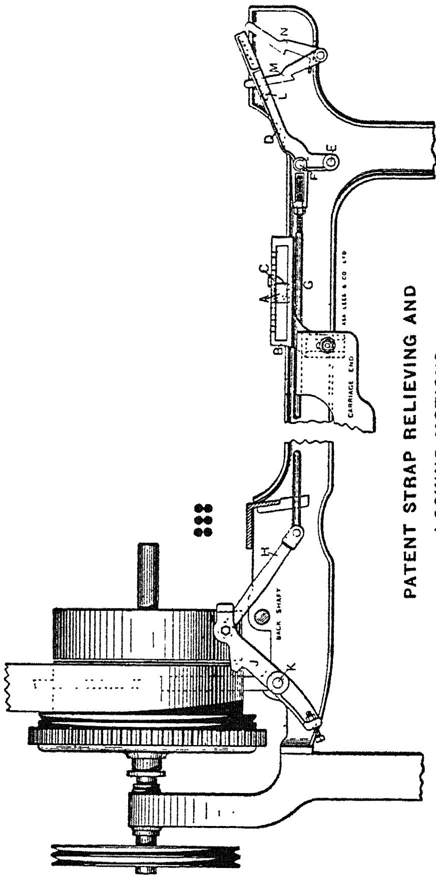
The whole motion can be adjusted with the mule running and without the use of a screw key.

Fixed on the carriage end is a frame B carrying a stud A. As the carriage moves outward this stud comes in contact with the inclined surface of lever D, which it depresses, and, being centred at E, the swivel F is taken with it. To this swivel F the end of the rod G is secured, the other end of which is connected to the lever H, which in turn is secured to the lever J. This lever is centred at K and the strap lever is secured to it.

It will be seen that if lever D is now pressed downwards the rod G will be pulled outwards, which, through the various levers, will operate on the strap fork lever and so bring about the desired change.

The moment at which this motion comes into operation may be regulated by sliding the stud A in its frame B, the stud being held in any desired position by turning down the catch C into one of the holes drilled in the upper surface of the frame B.

The locking device is for stopping the carriage at any part of the outward run, and operates as follows: When the lever D is pressed down, the lug L, which is cast upon it, is caught by the catch M, thus preventing the levers resuming their original position, and keeping the carriage



PATENT STRAP RELIEVING AND LOCKING MOTIONS

FIG. 78.

References to Diagram.

A Adjustable stud.
B Frame for ditto.
C Catch for keeping stud A in position.
D Strap relieving lever.
E Centre stud for ditto.
F Swivel.
G Strap relieving rod.
H Connecting rod.

J Strap lever.
K Strap lever shaft.
L Nog on lever D.
M Latch lever, shown in position when belt is locked on loose pulley.
N Latch lever in position when Mule is working.

stationary until released. When it is not required to stop the carriage the catch is turned back to the position shown at N, Fig. 78.

Q. 1909. What portions of the copping mechanism of a mule govern the build of (*a*) the cop bottom, (*b*) the parallel body of the cop, (*c*) the cop chase? State fully how the various parts of the mechanism are manipulated to produce these results.

A. (*a*) All such parts as the fallers, sector, locking lever, quadrant mechanism, copping rail, copping plates, shaper wheel and screw exercise more or less effect on the build of the cops at almost every stage, but the shapes and settings of the initial portions of the back and front copping plates may be said to mainly control the formation of the cop bottom along with the total incline or fall in the rail at the first draw. The initial portion of the back plate is much steeper or more inclined than that of the front plate, so that the back end of the copping rail drops more quickly than the front end. In this way the length of top cone or chase is quickly increased by the base point of winding-on being more slowly lifted than the terminal point of winding at each draw.

(*b*) The cylinder of the cop is formed after the coning inclines of the plates have been passed and while the "dies" or studs of the copping rail are supported by and are descending the long inclines of the two plates. If the cop body were not parallel we should mostly expect the two most likely causes to be either some defects in these long plate inclines, or else a wrong adjustment of the sector. If the winding-faller wire is not set in true relation to the sector stud the cylinder of the cop is likely to be more or less affected.

(*c*) The working profile of the copping rail itself is usually the principal factor in influencing the shape of the cop chase or top cone of the cop, although such mechanisms as the quadrant often influence this point.

Q. 1909. How are the following results attained during the working of a mule: (*a*) The prevention of the premature engagement of the backing-off friction during spinning and twisting at the head; (*b*) the prevention of the engagement of the drawing-up friction until the termination of backing-off? Show clearly the relationship which must exist between these motions throughout to ensure them working in harmony.

A. (*a*) During ordinary spinning and outward travel of carriage the backing-off friction is usually kept out of gear by the action of the disengaging action of the backing-off springs. Apart from this, it has long been the almost universal practice to link the backing-off parts to the down-belt rods and levers in such a manner that the latter obstruct the former even after the carriage has almost or quite finished its outward travel. To be more definite, a stud or other part attached to the fork-rod of the down-belt prevents the movement of a finger or lever linked to the long rod of the backing-off motion, until the movement of the down-belt from fast to loose pulley removes the obstruction when twisting has finished. In some cases a supplementary obstruction is provided by the long lever until the latter changes. The real use of the obstructing stud is displayed when the backing-off rod and spring are charged by the proper parts.

(*b*) As the carriage moves out the drawing-up friction is kept out by a stop from the long lever in some mules, or from the cam-shaft in other mules, coming beneath the short lever of this friction. Although this stop is removed when the carriage gets out, yet a second stop takes its place, and is operating by the same parts that charge the backing-off friction. The disengagement of the backing-off friction removes this second stop, and permits the taking-in friction to gear.

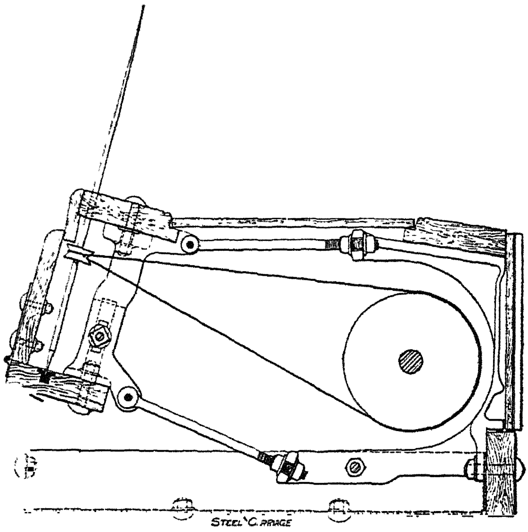
Q. 1913. State how the essential features of yarn differ when intended for twist and weft respectively. Give reasons for these differences, and state how each variety is twisted during spinning.

A. Referring to the two broad types of cotton yarn as required for the warp and weft respectively in weaving, it may be said that warp yarn is nearly always required to be stronger and harder twisted than weft yarn. Twist or warp yarn is necessarily subjected to a much greater amount of strain and tension than weft yarn, partly owing to passing through the preliminary processes of winding, warping, sizing, and drawing-in before reaching the loom. Weft yarn is frequently taken directly from the mule to the loom without any other treatment, while in other cases the treatment may consist simply of conditioning, packing, transit, and unpacking. At the loom itself the warp yarn is subjected to more severe treatment than the weft owing to the chafing action of healds

and reed, and the opening and closing action of the shedding operation. It is the almost invariable practice to put the twist into warp or twist yarn the twist way or clockwise, and a good deal of the weft yarn is also spun twist way. On the other hand a good deal of weft yarn is twisted anti-clockwise or weft way partly in order to produce a softer feeling cloth with a better cover upon it. For reasons above stated, it is often the case that stronger cottons are selected for the twist than for the weft yarns.

Patent Steel Carriage (Fig. 79).

The patent carriage and coupling shown in Figs. 79 and 80 are made by Messrs. Asa Lees & Co. Limited.



PATENT STEEL CARRIAGE
Fig. 79.

This carriage is lighter, stronger, more rigid, and takes less power than wood carriages.

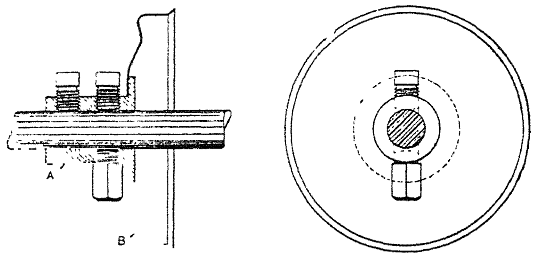
Each length of carriage has the body part made out of one sheet.

It runs lighter and quicker than wood carriages, and

therefore gives an increased production; it runs steadier, and therefore makes more regular yarn.

PATENT STEEL TIN ROLLER COUPLING (Fig. 80).

This patent coupling, or tin roller end, has been designed with the object of making the tin rollers as light as possible consistent with sufficient strength for the work they have to do. The tin roller end B is pressed out of sheet metal, into a shape which, by experience, has been found to be the best to withstand the strains developed in working, and is then electrically welded to a turned steel boss A.



PATENT STEEL TIN ROLLER COUPLING
FIG. 80.

The reduction in weight secured by this improvement averages 150 lb. per mule (on long mules it will be as much as 200 lb.), and, as will be readily seen, this effects a large saving in the power required to drive and reverse the tin rollers, not only causing the mule to run lighter and give an increased production, but resulting in a considerable saving in spindle bands and rim bands.

Q. 1910. How are the spindles of a mule driven (*a*) during the outward movement of the carriage, and (*b*) during the inward movement? Show clearly how these motions are prevented from interfering with each other during the working of the mule. 25 marks.

A. The spindles are always driven directly from the tin rollers whether the mule is coming out, going in, or backing-off. The tin roller shaft is driven by the rim band directly from the rim pulley on the rim shaft during coming out and backing-off, but it is driven from the quadrant, winding

chain, and winding drum mechanism during the inward run of carriage. We have, therefore, two distinct mechanical combinations connected to and capable of driving the tin roller shaft, and one must be in some way disengaged while the other is operating.

Various forms of friction and clutch-box arrangements have been experimented with on the tin roller shaft to obtain the requisite engagement or disengagement of these parts, but the almost universally adopted system is to employ the well-known spectacle spring, ratchet wheel, and catch or click combination. As the carriage moves out the click presses against the spring finger in such a manner as to hold the catch out of gear with its wheel, and this holds good also during backing-off. During winding-on, however, the catch is held in the opposite manner against the spring, and this makes and maintains engagement of the quadrant connections with the tin roller shaft. A little return action now passes through the rim band back to the rim shaft, but does not matter, because the roller and back shaft boxes are opened and the belt on loose pulley. (See Figs. 63, 64.)

Q. 1910. Sketch and describe the tin roller twist motion as applied to a mule, and state its advantages and disadvantages as compared with the rim shaft motion.

A. When a twist motion is used it is the practice to latch the belt lever or rod, so as to keep the belt on its fast pulley until unlatched by the operation of the twist motion. Most twist motions are operated by a worm on the rim shaft, as this is the simplest and most convenient method. The rim shaft twist motion does not, however, make any allowance for variable slippage of rim band, and therefore during recent years a good many firms have applied tin roller twist motions. The usual practice in such cases is to loosely connect a long rod to the belt lever parts, and extend the rod forward to cover the full extent of the traverse of the tin roller shaft with the carriage, and to conveniently latch the rod. A worm on the tin roller shaft drives a worm wheel compounded with a small driving wheel, and both revolving upon a stud. The second driver wheel is compounded with a cam or finger, which upon completing a revolution releases the long rod connected with the belt fork, and the belt is at once drawn by a spring upon the loose pulley. There may

be a slight loss of twist due to forward movement of tin roller shaft during winding-on, and to prevent this some firms now disconnect the tin roller twist motion during winding-on. Greater simplicity of parts is the chief advantage of the rim shaft motion, and rather more equal and fuller twist the great advantage of the tin roller motion.

Messrs. Asa Lees' excellent arrangement is sketched and described below.

Improved Twist Motion (Fig. 81).

Driven from Tin Roller Shaft.

This motion is designed to put the required twist in every

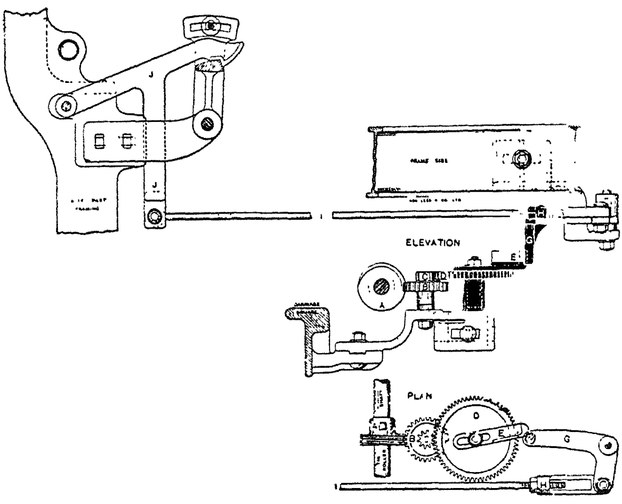


Fig. 81.—Tin roller twisting motion. Asa Lees.

References to Diagram.

A Single thread worm on tin roller shaft.
B Worm wheel, 40, 45 or 56 teeth.
C Carrier wheel compounded with B, 14, 15 or 20 teeth.
D Twist change wheel, 50 to 100 teeth.
E Twist finger.
G Bell crank lever.
H Adjusting swivel.
I Connecting rod.
J Twist motion catch.
K Nog on strap lever.

draw alike. The motion being driven by a worm on the tin

roller shaft, ensures this shaft, and therefore the spindles, making the same number of revolutions each draw.

The twist catch J is hinged at the back of the headstock as usual, and is connected by the rod I to the bell crank lever G, which is pivoted on a bracket secured to the headstock side. A bracket is fixed on the square which carries the twist motion wheels C and B, and to this bracket a slide is fitted carrying the twist wheel D. This slide can be adjusted to take any size of wheel from 50 to 100 teeth. It will thus be seen that the worm A on the tin roller shaft transmits motion to the wheels B and C, which in turn drive the change wheel D, whilst on the same stud, and secured to wheel D, is a finger E revolving with wheel D.

When the carriage has completed the outward run, the tin roller shaft continues to revolve until the finger E comes in contact with the bell crank lever G, which, being turned on its centre, exerts a pull on the rod I, and thus lifts the catch J, allowing the strap lever K to move the strap on to the loose pulley on the rim shaft previous to the mule backing-off.

Q. 1910. Describe the holding-out catch arrangement of a mule, and state its objects. State what is the result of its failure to engage, and how it is released previous to the inward run of the carriage.

A. The holding-out catch of a mule is a short, strong lever placed at the out end of the headstock, so that a strong stud or catch point in the carriage just reaches the catch, and is latched therewith at the termination of each outward carriage traverse, so as to prevent reaction or moving back of the carriage until after backing-off. The various motions for drawing the mule out and in are all disengaged during backing-off, and it is quite possible to work a modern mule without holding-out catch. A good many mules, however—probably most—tend to re-act back slightly at the finish of the outward run, and this tends to put pin-head snarls in the yarn, and in many mules it eases the gearing of the backing-off friction very slightly, while also in many mules it tends to produce the very serious defect of premature engagement of the winding catch, and thus to lock the tin roller shaft and prevent backing-off. In some mules the holding-out catch is disengaged by the same strong spring that engages the taking-in friction; in other mules by a connection from the

backing-off rod, and in yet other mules the catch is lifted by the second change of the long lever.

Q. 1910. Explain how the fibres contained in the length of yarn between the roller nip and spindle points of a mule are affected by the combined action of the revolving spindles and moving carriage, and compare this with the action of the ring frame on the length of yarn from roller nip to bobbin. How do these differences affect the final disposition of the fibres and the construction of the two yarns generally?

A. There is a tendency for the longer fibres to form the centre of the yarn and for shorter fibres to project therefrom, and to give a softer, more hairy and fuller appearance to the yarn, this being a distinctive feature of mule yarn not produced as much in ring yarn owing to the latter being wound upon the bobbin immediately after delivery from rollers. The mule spinning system also permits of gain of carriage and "ratch," and these actions tend to draw out any portions of yarn that are thicker than others, an effect aided by the natural tendency for twist to run into the thinner portions which therefore resist the tension. In this respect also the ring frame system is inferior to the mule.

Q. 1907 Is the total draft in a mule greater or less when spinning very fine counts, as compared with medium? State your answer fully.

A. The total draft of a fine spinning mule is generally a good deal greater than that of a medium spinning mule. For example, in spinning 30's from single roving a 4-hank roving might be used, this giving a total draft of $30 \div 4 = 7\frac{1}{2}$. Comparing this with the spinning of 90's for the latter counts we might use a 14 hank roving used double, thus requiring a total draft of $90 \div \frac{14}{2} = 13$ almost. In the case of 30's practically all of the $7\frac{1}{2}$ total draft for American cotton might be obtained from the rollers, and carriage draft be entirely or almost entirely absent. For the 90's, however, there would be a fair amount of gain and ratch, and this carriage draft would cause the roller draft to be proportionately reduced. The use of double roving at the mule for the fine counts is an even more important factor in requiring a high draft for fine counts, than is the fact of the counts of yarn being fine, since the latter is commonly met by using a finer hank roving.

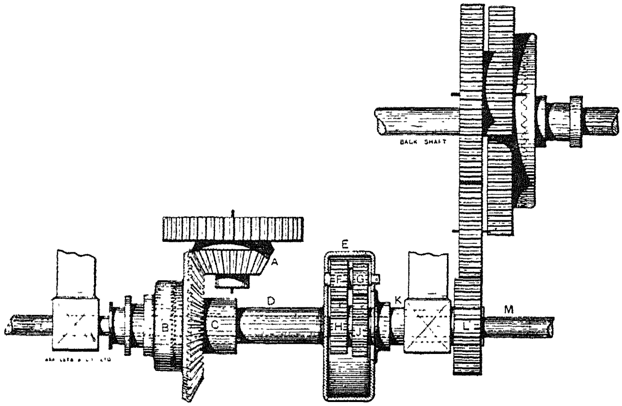
Q. 1913. Describe the mechanism used on a mule for controlling the slack yarn liberated by the unlocking of the fallers at the termination of winding. State what advantages are obtained from the use of this motion, and the circumstances under which it is mostly used.

A. This question may be taken by different people to refer to any one of about three or four different motions, such as the anti-snarling motion, which acts by making use of wide slots in the internal disc of the roller-box; or the assistant winding or snicking motion in which an extra narrow belt is used with special fast and loose pulleys on the rim shaft; or the special winding-faller lifting motion. The anti-snarling motion depends for its action upon retarding the rollers for a moment after the carriage has started outwards, so as to promptly stretch out any snarls caused by unlocking the fallers. In most cases this motion centres around the internal disc of the roller-box, which is made with spaces of varying widths. In some mules a weighted buffalo lace is used to pull the stud or peg that drives the disc to a regulated amount backwards every time the roller-box opens. This "pull back" must be made good again at every start out before the rollers commence turning, and by this means we obtain the snarl stretching effect. The assistant winding motion is an entirely different mechanism from the snarling motion, and it is seldom used excepting for fine spinning mules, whereas the roller-box motion is used largely for coarse and medium yarns. With this extra winding motion an extra pair of fast and loose pulleys, each about 12 inches diameter, may be placed on the rim shaft, and these are driven round at a much slower speed than spinning speed by a special belt. This belt is always on the loose pulley, excepting for the last few inches of the inward run of carriage and for more or less of the time occupied by the lifting of the fallers. The inward movement of the carriage trips the belt upon its fast pulley at the required moment, and then for a very brief period the driving of the spindles is transferred from the winding chain.

Differential Jacking Motion (Fig. 82).

This motion is for the purpose of driving the carriage during the last few inches of the outward run, after the rollers

are stopped to stretch the yarn, as is customary in spinning fine counts. The speed wheel carrier bevel A, drives the front roller through the bevel C and the catch box B and an internal disc which is keyed on the front roller-shaft. When the catch box is put out of gear the front roller is stopped. The bevel C is keyed on the boss of the jacking box D and E.



IMPROVED JACKING MOTION

FIG. 82.

References to Diagram.

A Speed wheel carrier bevel.
B Front roller catch box.
C Front roller catch box bevel.
D, E } Jacking box.
F, G } Pinions, keyed together, but working loose in box.
H Pinion keyed on front roller-shaft.
J Pinion keyed on long boss.
K Long boss.
L Long boss pinion.
M Front roller-shaft.

and runs loosely on the front roller-shaft. Inside this jacking box two pinions F and G are mounted, which are keyed together, but run loosely inside the box. These pinions gear with two wheels H and J, H being keyed on front roller-shaft and J on the long boss K. By reason of the wheels F and G being of different sizes, and being carried round the outside of the wheels H and J by the jack box, motion is transmitted to the wheel J, which, being keyed on the boss K, on the other end of which is secured the wheel

L, drives the back shaft in the ordinary way but at a reduced speed.

This motion can be operated to cause any desired amount of stretching of the yarn, and is made by Messrs. Asa Lees and Co.

Q. 1911. State how you would arrange the amount and direction of twist, and size of cop to be made in spinning yarns intended for (*a*) warping, (*b*) weaving weft, and (*c*) hosiery weft. Give full reasons for any differences you describe, and state the effects desired in each instance.

A. (*a*) Cops intended for warp yarn are usually made as large in size as may be convenient, since in this way the amount of doffing at the mule is kept low, and the cops last longer at the winding frame, while there is no reason against this practice in winding or warping. A much used standard is $1\frac{3}{5}$ inch gauge, making a cop possibly $1\frac{1}{4}$ inch diameter, multiplied by possibly $7\frac{1}{2}$ inches or so in length. Warp yarn is almost all spun twist way as this suits both the spinner and the weaver, and every one has become accustomed to it. Twist multiplier = $\sqrt{}$ counts × $3\frac{3}{4}$ for American; twist multiplier = $\sqrt{}$ counts × 3·606 for Egyptian. (*b*) Weaving weft cops in medium numbers are usually $4\frac{3}{4}$ inches to $5\frac{1}{4}$ inches in length × $\frac{3}{4}$ inch to $\frac{7}{8}$ inch diameter, according to the size of the shuttle. Larger sizes are used for coarser yarns and some kinds of cloth, but shuttle dimensions for medium and finer yarns often preclude larger sizes of cop. Weaving weft is twisted either weft way or twist way as required by the customer, and according to the particular effects required in weaving or dyeing. Twist = $\sqrt{}$ counts × $3\frac{1}{4}$ inches for American, or 3·183 for Egyptian. (*c*) Hosiery weft is usually made into cops similar in size to warping cops and twisted same way, but with reduced twist per inch to suit the soft nature of goods to be made.

Q. 1911. Enumerate the various motions which may be used to actuate the rollers of a mule at different times during one complete draw. State briefly the objects of these motions, and the circumstances under which each of them may be advantageously used.

A. On a great many mules there is only one roller-driving motion, *i.e.*, the indispensable one for driving the rollers dur-

ing spinning when the carriage is receding from the roller beam. This is used on all mules and in every case the rollers are driven from the rim shaft by a train of four or six wheels, containing large driven and small driving wheels in order to get sufficiently low speed of front roller. The next roller driving motion in extent of use is the "winding roller delivery" by means of which about $3\frac{1}{2}$ inches of yarn are delivered to each spindle during each run-in of the carriage. In this way production may be increased, and this particular motion is in general use for long staple cottons and good American. For short staples such as Indian and moderate American, many firms prefer not to apply this motion owing to a suspicion of thread breakage, and also to the fact that spindle speeds are already as high as can be obtained without also having to put twist in during spinning for the extra yarn delivered during winding. The third roller motion is almost confined to fine and medium fine spinning mules, and is not always used even in such cases. Its object is to deliver a very slight amount of yarn to each spindle during twisting at the head, and often also during ratching, to prevent excessive thread breakage by yarn contraction due to twist, or by tension during stretching. By means of this so-called receding motion the rollers are given an almost imperceptible movement by a train of gearing originating at the rim shaft, but involving worm and worm wheel gearing to obtain a rapid reduction in speed.

Q. 1911. Fully explain the meaning of the term "depth of faller lock" as applied to a mule, and describe how this adjustment is maintained throughout the build of the cop. State also how this factor influences the unwinding of the cop.

A. This question involves a knowledge of the particular functions of the loose front incline of the copping rail. Formerly the front and back inclines of the copping rail were all cast in one piece, and no middle plate was used, with the result that faller locking the first draw after doffing might occur at the apex of the piece of cop, and yet later on the depth of faller lock might be so excessive as to break the threads. By depth of faller rock is meant the amount the winding-faller wire is taken below the apex of the cop during backing-off, before the fallers are locked into winding-on position. It is advisable to have this depth kept within

reasonable limits for all stages of the cop building, and this effect is obtained having a loose front incline, supported by a special copping plate to itself. This plate is very much of the same shape as the back plate, so that the initial and terminal extremes of the rail—representing the beginning and the end of winding-on—are lowered in any ratio desired, and the depth of lock is neither too shallow at the beginning, nor too deep at the full thickness of cop, as was formerly the case. This helps to obtain good cop noses and to distribute the crossing coils or yarn on the cop noses with the net result that somewhat improved unwinding and reduced waste may be obtained if the parts are adjusted and controlled to the best advantage.

Q. 1912. Describe the position of the spindles of a mule relative to the rollers, when the carriage is in its nearest position to the roller beam. State the technical terms used to denote this setting, and describe how the operation of spinning is affected by it.

A. The three conditions of spindle particularly affecting this point are (1) distance of spindle point below the rollers; (2) distance of spindle point in front of rollers; (3) bevel of spindle. The first-named more particularly comes under the heading of "topping of spindle," while "bevel" means the inclination of spindle point towards the rollers. For American cotton spinning medium counts of yarn the spindle tops may be $2\frac{1}{2}$ inches below top of front steel roller, and $2\frac{1}{2}$ inches in front, when the spindles are in their closest position to the rollers. These distances are increased to 3 inches or $3\frac{1}{4}$ inches down, and $3\frac{1}{4}$ inches up to $3\frac{3}{4}$ inches or 4 inches in front, as the counts of the yarn become finer. The amount of spindle bevel varies from $3\frac{7}{8}$ inches to 6 inches in the spindle length, the finer counts taking the greater inclination. "Topping," "distance," and "bevel" all affect the operation of spinning. "Topping" and "bevel" enable the threads to keep twisting over the spindle points without breaking, and the absence of these features would cause the threads to wind round the spindles and break off. An excess amount of topping and bevel will tend to put snarls into the yarn, while thread breakage results from too little.

Q. 1912. Sketch and describe the mechanism used on a mule for re-winding the quadrant chain on the

drum during the outward movement of the carriage. If this action is inefficiently performed, what defects would you expect to be developed?

A. It is the invariable practice to extend the shaft upon which the winding-chain drum is secured so as to contain also a rope pulley or drum, by means of which the drum shaft is rotated the opposite way during outward carriage travel, and the winding chain is thus wrapped round the drum ready again for the next run-in of carriage. Two leading methods are in extensive use for giving the return movement to the drum shaft, the one depending entirely upon friction and the other upon the positive pull of a weighted rope. The frictional method is most used for mules spinning American cotton and running quickly, while the positive method is more in use on mules spinning Egyptian or Sea Islands yarns, although there is no strict or necessary adherence to this general practice. In the positive method one end of the rope is connected to a vertically sliding weight, while the other end passes round suitable guide pulleys, and several times round its drum on the drum shaft to which drum it is then attached. The weight is always trying to turn the drum shaft, and wind the chain upon the drum, while the chain is pulling round in the opposite direction at the shaft. In the frictional method the band is secured to the headstock framing at the back, and is tied to a weight at the front of the headstock. The rope drum rubs against this rope as the carriage moves out, and in this way the chain is returned to the chain drum. If through slackness, wrong adjustments, or other causes the rope did not give proper rotation to the chain drum, the chain would be more or less slack at the start-in of the carriage, and this would give a loss in winding and a slackening or snarling of the threads proportionate to the amount of loss in winding.

Q. 1913. State what changes are usually put into operation by the locking of the faller leg of a mule, and fully describe the manner in which they are effected. You may select for your answer any type of mule with which you are acquainted.

A. The changes which take place at the locking of the fallers of a mule are much the same on any make of mule, and include releasing of the holding out, disengagement of the backing-off friction, engagement of the taking-in friction,

and in many cases gearing of the winding catch. The backing-off click should also move out of gear. In the Platt's mule, for example, the taking-in friction and the holding-out catch are in a manner linked together by a long rod extending beneath the carriage, so that the same very strong spring that puts the friction into gear also lifts the holding-out catch. Also connected to the same long flat rod is a small adjustable bracket which comes against the tail of the long finger of the winding catch, so the movement of the long rod also gears the catch. The locking of the fallers is accompanied by the lifting of the fish-jaw lever so as to take the charge from the long backing-off rod or charge rod, and thus permits the spring on this rod to disengage the backing-off friction. This movement of the charge rod also releases the cross lever of the taking-in friction. The forward movement of the carrier pulley of the backing-off chain promptly slackens this chain.

Q. 1913. State to what extent the taking-in action of a mule is assisted by the long back shaft, sketch and describe the mechanism which actuates the shaft during the inward movement of the carriage.

A. About 1887 the practice began to be adopted of directly connecting the short scroll shaft with the long back shaft, to enable the latter to give more assistance in drawing the carriage inwards in a straighter and steadier manner. It had been noticed by many operative spinners that very tight jack bands or carriage bands at the headstock had a tendency to check plucking in by starting the back shaft sooner. The back shaft only has rotation given to it during running in, indirectly from the carriage, but the introduction of the steady band enables us to give the back shaft more direct and prompter driving during each run in. Naturally, as soon as the long back shaft begins to turn, it helps to pull in the carriage at several points owing to the use of six or seven pairs of carriage bands. The introduction of the steady band led to the adoption of an extra scroll on the short taking-in shaft, and a companion scroll on the long back shaft at the headstock. There can be no doubt about the average benefit arising from the use of the steady band. Indeed, there are many mules now equipped with two steady bands and only one thick scroll band directly secured to the back of the carriage square.

Q. 1914. Describe, with the aid of sketches, how the "backing-off" friction of a mule is engaged and disengaged. State what factors govern the duration of the backing-off period, describing how this may be increased or decreased in extent.

A. Speaking without definite reference to any particular make of mule the usual practice is to link up the fork of the backing-off friction by a lever and long rod connection to the front of the headstock. Shortly before the carriage terminates its outward traverse, a bracket finger or lever in the carriage square comes against the front lever of the long backing-off rod, so that the said long rod is moved through a space of possibly 1½ inches or so—this is a variable distance—in the direction necessary for moving the backing-off friction into gear. It is customary for the long rod to charge the fork lever through the intercepting medium of a strong backing-off spring, but this spring cannot gear the friction until twisting has finished and the down-belt is moved upon the loose pulley on the rim shaft. In this way is prevented the evil of the down driving belt driving the rim shaft one way and the friction trying to drive the rim shaft the opposite both at the same time. The spring being ready charged by the carriage, promptly gears the friction as soon as permitted by the movement of the down belt upon its loose pulley.

It is now a very common practice to have two strong springs connected to the long backing-off rod, both of which are charged by the outward movement of the carriage, but the second one being connected at one end to the framing is utilised only for disengaging the backing-off friction at the proper time. This occurs when the fallers lock, because means are provided for then disconnecting the long rod of the backing-off friction from the gearing pressure induced by the outward carriage traverse. Locking of the fallers, therefore, is accompanied by the prompt disengagement of the friction by the strong disengaging spring, which forcibly moves the long rod and its connections back into spinning position.

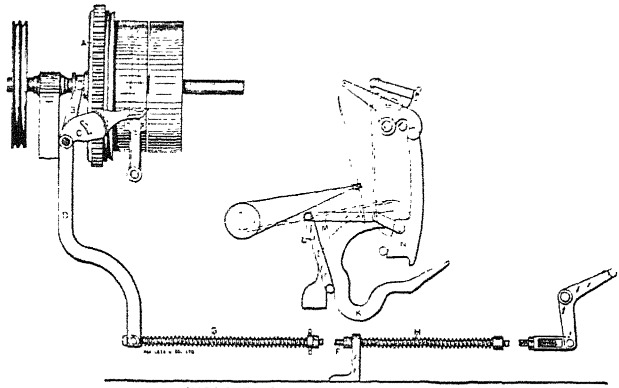
Provided there is prompt and effective engagement of the friction at the proper time, the speed of backing-off is controlled by the speed of counter shaft, and the dimensions of the pulleys and wheel by which the backing-off friction is driven. Frequently, however, the backing-off friction does

not do its work in the most effective manner, and there is evidence that something is wrong with its working. Remedies for slow or ineffective action are often found in such adjustments as putting the friction deeper in gear, tightening the backing-off spring, re-setting the rods and levers to better advantage, taking care that no obstruction is hindering the free movement of the rods, levers, springs, and friction. A drastic remedy is skimming up or re-covering the friction cone with leather. A tighter backing-off chain will cause the fallers to lock sooner, and thus give slightly quicker backing-off.

Below is reproduced sketch and description of the backing-off mechanism of Messrs. Asa Lees of Oldham.

Backing-off Motion (Fig. 83).

The object of the above motion is to unwind the coils of



IMPROVED BACKING-OFF MOTION

Fig. 83.

References to Diagram.

A Backing-off wheel.
B Backing-off fork.
C Adjusting backing-off finger.
D Long backing-off lever.
E Bowl on strap lever for regulating backing-off finger.
F Long backing-off rod.
G Backing-off spring.
H Spring for pulling wheel out of gear.
J Bell-crank lever for fish-jaw.
K Fish-jaw.
L Monkey-tail lever.
M Boot-leg connecting rod.
N Boot-leg.

yarn formed on the spindle blade during spinning, in order

that the spun yarn may be wound on the cop, and this is done by turning the spindles in the opposite direction, the slack yarn thus formed being taken up temporarily by the counter faller.

The backing-off wheel A is mounted loosely on the rim shaft and is driven constantly in an opposite direction to the rim shaft during spinning. When the carriage completes its outward run the lever K, which is mounted in the square, depresses the lever J, which moves the rod F and allows the spring G to turn lever D on its centre and so force the backing-off wheel, the inside of which is turned conical, on to the friction cone connected with the fast pulley and thus driving through to the spindles in the usual manner but in the opposite direction.

The winding faller is pulled down by the backing-off chains in the usual manner—through a click wheel on the tin roller shaft—until the bottom end of the boot-leg N rests on the locking bowl connected with the slide on the shaper rail; in which position the fallers are said to be "locked". During this operation the lever K is raised, through the levers L and M, and the lever J is released, allowing the spring H to draw the backing-off wheel out of gear.

To prevent this motion coming into operation too soon, a finger C rests on a bowl E connected to the strap lever, and prevents it dropping until the cam is changed and the strap is moved from the fast to the loose pulley, thus preventing the backing-off friction going into gear before the strap is moved entirely on to the loose pulley.

Whilst backing-off, the button-head on rod F must be $\frac{1}{4}$ inch clear of the long lever D. (See also Fig. 60.)

Q. 1914. Describe how the driving of mules is usually effected from the line shaft, stating which portions of the mule are independently driven. State your opinion of the advantages and disadvantages of duplex driving as compared with the single drive, giving full reasons.

A. The three small illustrations given below fully indicate the ordinary plain method of driving from line shaft to counter shaft, and from counter shaft down to the headstock, both for drawing-out and taking-in of the carriage. The large drum L on line shaft gives motion by the long top belt to the fast and loose pulley C on the counter shaft CS. The

large belt drum D on the counter shaft drives the mule during the run-out of carriage, while the small rope pulley T drives the mule during the backing-off and taking-in.

Referring first to drawing-out or spinning, the down belt reaches from large drum D to the fast and loose pulleys F of about 16 inches diameter on the rim shaft. The fast F is keyed to the rim shaft, while the other pulley runs loosely thereon. At or near the end of the run-out of carriage the down belt is moved upon the loose rim-shaft pulley, and is practically out of action until the carriage again reaches the back stops. For backing-off the large friction dish M is forced into gear with the leather-covered cone on the fast pulley F, and drives the rim shaft in the reverse direction. By means of the "rigging" band the top rope pulley T is always driving the pulley R on the side shaft, and a small spur wheel on the side shaft drives the large friction wheel M, while a bevel wheel on the same side shaft drives a bevel fixed on the vertical taking-in shaft.

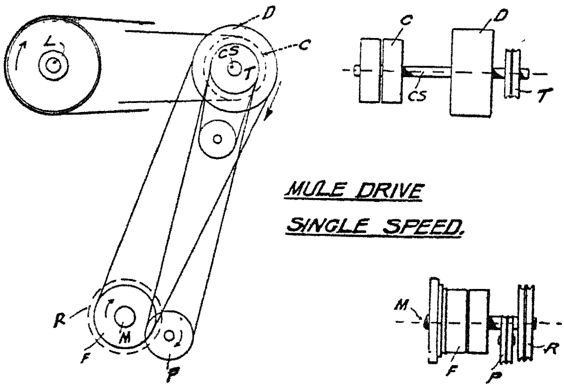


FIG. 84.

The backing-off and taking-in clutch halves are always being rotated so long as the counter shaft is working, but are harmlessly rotating so long as the respective friction clutches are not in gear.

In regard to duplex driving, this method requires two narrow fast and loose pulleys at F, and two narrow down belts moved about by the same belt fork. In this way two

belts of $2\frac{3}{4}$ inches width each may be used, giving a driving width of $5\frac{1}{2}$ inches with a side traverse of only 3 inches. With only one belt a $4\frac{1}{2}$ inch belt is still one inch smaller in driving width, and yet it possesses the disadvantage of having to be frequently moved backwards and forwards across the pulleys for about $4\frac{5}{8}$ inches, as compared with the 3 inches of the duplex belt. Reduced wear of the edges of the belt, increased driving power, and quick changing from one pulley to the other, are the chief advantages of duplex driving. Its disadvantages are, the tendency for one belt to become tighter than its companion, for one belt to break and become entangled with the machinery, while the other continues to drive the mule, and a tendency to spring the mule carriage out by a very quick change from loose to fast pulley. The adoption of strap relieving motions and improved belt forks has diminished the merits of duplex driving. Both systems are very extensively adopted. Naturally, the duplex driving takes up a little extra length of rim shaft, and adds another belt for care and upkeep.

Mule Drive. Double Speed.

Most people prefer to obtain the single and double speed motions—sometimes applied to fine spinning mules—from a duplication of top driving to driven pulleys.

In the several small sketches grouped under Fig. 85, L represents the line shaft, S the single speed drum on line shaft and B the larger or so-called double speed drum. There are two top driving belts, each driving to a set of three pulleys on the counter shaft. S^1, S^2, S^3 are the pulleys for single speed and B^1 B^2 B^3 the pulleys for double speed. Each set contains one fast pulley and two loose pulleys. From the counter-shaft large drum D the drive is continued down to the two fast and loose rim shaft pulleys at F. T is the drawing up pulley and P the slow spindle speed pulley for the fine rim motion.

For ordinary spinning the top belts are on pulleys S^2 and B^2 of which S^2 is fast and B^2 is loose. For double speed the two belts are moved upon pulleys S^3 and B^3, of which S^3 is loose and B^3 is fast to counter shaft, and this movement occurs just before the carriage gets fully out.

When the carriage again reaches the back stops, the belts are moved back upon pulleys S^2 and B^2.

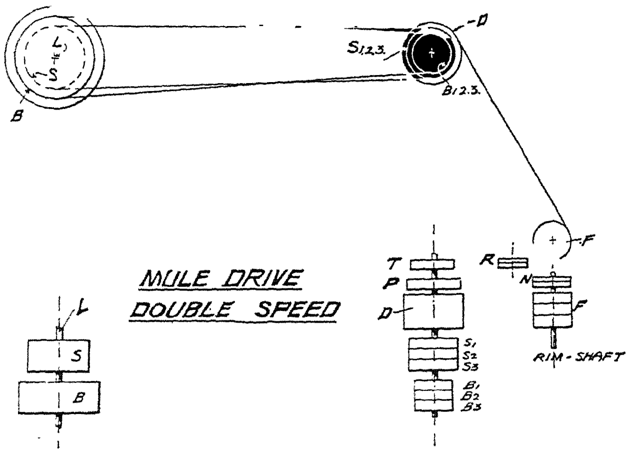


FIG. 85.

For mule completely stopped the two belts are moved upon pulleys S^1 and B^1 which are both loose.

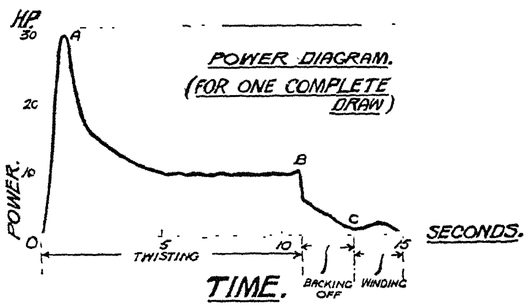


FIG. 86.

DRIVING POWER FOR MULE.

In making one complete draw the power required to drive a mule varies greatly as indicated by the diagram, Fig. 86.

Reading from the left the power is much the greatest when the carriage is starting from the roller-beam, as per point A, and soon settles down to steady drive for a few seconds as per line B.

For backing-off the power drops to a small amount as per point C, increases somewhat during taking-in, and finally drops a second or so to practically nil just before the carriage gets in.

Q. 1909. What are the principles which should govern the arrangement of the fibres in the yarn to give the best results in regard to strength, evenness, and elasticity? Which system of spinning gives the nearest approach in practice to these theoretical conditions, and why?

A. To obtain the best results in the points specified the fibres should be cleaned and parallelised as far as possible. At the spinning machine also two ends should be put up together in order to get the maximum uniformity and strength. Other conditions being equal, that is, given equal rovings, machines in good order, workpeople and general surroundings approximately equal, we may expect the mule in most cases to give rather better results than the ring frame, especially in the finer counts, owing largely to the possible utilisation of the principles of ratch and gain on the mule, and not on the ring frame. Cases exist, however, where quite fine counts are spun on the ring frame, and the uniformity and pull of the yarn are little, if any, inferior to the mule yarn. It need hardly be added that careful and skilful manipulation of the machines may improve the quality of the yarn. The spinning of successive stretch lengths of yarn on the mule before winding on permits an equalising effect to run all the threads as the carriage moves outwards, and there is not the same chance of equal distribution of twist, and of carriage draft levelling the yarn on the ring frame as there is on the mule.

Q. 1909. During the building of a set of cops on the mule, what effect has the gradually decreasing length of bare spindle on (*a*) the unlocking of the fallers, and (*b*) the backing-off revolutions of the spindles? How are these varying effects automatically adjusted during the working of the mule?

A. (*a*) At the commencement of a set of cops, when the

fallers are unlocked the unlocking must take place sufficiently soon to allow of enough slack yarn for coiling round almost the whole working length of spindle blade. As the cops increase in length, however, the amount of slack yarn required for coiling round the bare spindle become proportionately less, and means must be provided for preventing too much slack yarn. Compensation is allowed for this in a very simple manner by using an inclined unlocking bracket, so that as the cops lengthen the unlocking point becomes proportionately later. The problem is also more or less affected by such things as "the hastening motion" in medium counts, the narrow belt of "the snicking motion" on many fine mules, and to some extent also by the shortening of the working length of long incline of copping rail.

(*b*) The gradually diminishing length of bare spindle blade, and therefore of the amount of yarn coiled round the spindle blade, also affect the backing-off, since an essential part of the backing-off operation consists in uncoiling this yarn before the fallers are locked. Fewer backing-off revolutions are wanted when the cops are nearly full, and this to a large extent is met by the simple fact that the fallers are locked sooner and higher up the spindles for full than for empty cops, so there is not time with full cops for much yarn to be backed off the spindles.

Another important effect has to be noted in connection with the reduced amount of yarn to be uncoiled from the bare spindles with full cops in backing-off. The winding-faller wire at the commencement of a set of cops has a comparatively long distance to travel before reaching the locking point, and only a short distance to travel before locking for full cops, so that if the downward movement of the wire were to commence equally soon for empty as for full spindles, the threads would often be pulled down too tightly for empty spindles, and too slackly for full ones, thus giving bad cop noses in the latter case. In very many cases, therefore, it is usual to have the backing-off chain to be comparatively slack just after doffing, and to be automatically tightened as the cops lengthen.

CHAPTER V.

RING SPINNING.

Q. Is yarn ever spun on the bare spindle of a ring-frame, and to what extent?

A. There is no doubt that yarn can be and is spun to some extent on the ring-frame on the bare spindle, or on small tubes such as are commonly used in mule spinning.

In England, however, the system does not appear to have yet attained any degree of commercial success. Almost innumerable attempts have been made to attain this object, very many such attempts never having been made public.

The author has often seen cops spun in this manner, and some of them have appeared to be very well built. When, however, the thing has to be done on a commercial scale under mill conditions there appears to be only very moderate success. In actual practice, as compared with mule spinning, the cops are often softer, do not "ready" as well, and have not as good noses, while the spinning is very bad, and the production is too limited. After conditioning it is difficult to skewer such cops. Some samples have come out well in these respects.

With the ordinary travellers there is too much strain on the thread when winding on the bare spindle, and various special forms of traveller have been adopted. Ring spinning upon small pirns or bobbins is now done in many cases.

Q. In what consists the chief difference between mule and throstle yarn?

A. Probably the greatest and most common differences consist in the mule yarn always being more elastic and more oozy or porous than throstle yarn. This is due to the long portion of thread spun during each stretch allowing some fibres to be projected out from the body of the thread, and to the principles of "ratch" and "gain". Taking the same counts,

the flyer throstle yarn is the roundest and strongest, and usually the ring-frame yarn comes next, with the mule yarn, last. This is when good level rovings are supplied; but with poor and unlevel rovings it is quite likely that the mule will give the stronger yarn, partly because of the action of "ratch" and "gain".

Often the mule yarn is weakened and cut at the lighting-in of the carriage against the back stops, and by such things as late unlocking of the fallers.

The roundness of the flyer throstle yarn is largely due to its passage round the flyer leg and to low spindle speeds.

Q. In ring spinning the diameter of the ring, the lift of the bobbin and the weight of the traveller vary according to the counts of yarn to be spun. Give the diameters of the rings, lifts of bobbins, and numbers of travellers suitable for the following yarns: 8's to 12's, 16's to 20's, 24's to 28's, 30's to 36's.

A. The following table gives approximately correct particulars:—

Counts.	Inside diameter of Rings.	Lift of Bobbins.	Number of Travellers.
8's to 12's	$1\frac{3}{4}$ in. to 2 in.	5 in.	8's to 6's
16's „ 20's	$1\frac{5}{8}$ „ or $1\frac{3}{4}$ „	5 „	4's „ 2's
24's „ 28's	$1\frac{5}{8}$ „	5 „	1/0 „ 3/0
30's „ 36's	$1\frac{5}{8}$ „ $1\frac{1}{2}$ „	5 „	4/0 „ 7/0

Note.—A good anti-ballooning apparatus is supposed to save an eighth inch "gauge". Double roving from Sea Islands and Egyptian cottons will take 4 to 6 counts heavier traveller than above.

Q. Describe the mode of regulating the drag on the common throstle and the ring-frame.

A. (*a*) In the former the drag is regulated by the bobbin being rested upon a piece of flannel, which resists and prevents the bobbin from being pulled round too freely by the yarn—the coarser the counts and greater the drag given by means of rougher flannel, etc.

(*b*) On the ring-frame the drag is regulated by putting on a lighter traveller for finer counts or a heavier traveller for coarser counts.

Q. Is yarn spun on the ring-frame ever used as picking weft? If so, what is the character of the cloth as compared with cloth picked with mule weft?

A. A fair amount of ring yarn is now used as weft.

The cloth is harsher to the feel, and does not appear to "cover" as well as with mule weft, nor will it stretch out as much.

Q. Describe the methods of weighting the top rollers of a ring-frame.

A. It is usual on a ring-frame to have the back top roller of large diameter and self-weighted. Very often the middle top roller is also self-weighted, although of small diameter. As shown in Fig. 87, in such cases it is usual to suspend a dead weight from the top roller, and it is convenient to have a long weight to serve for one top roller on each side of the machine at the same time. G are the weights; E, the hooks; H, the roller beam; A, the roller stands. In many cases the front and middle top rollers are saddled and bridled together and weighted by a lever arrangement. (In Fig. 87 the weights, G, should have been made shorter, with the hooks,

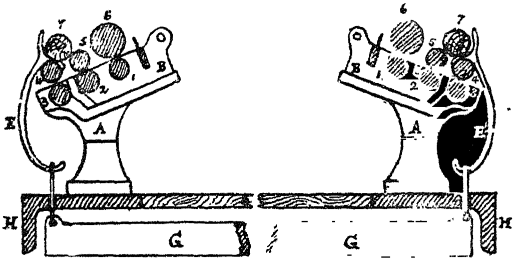


Fig. 87.

E, pulling inwards at the bottom to prevent the front top roller from bearing against the front of the cap nibs.) Occasionally all three lines of rollers are saddled and bridled together as on a coarse mule and are similarly lever weighted.

Q. What is the use and arrangement of the thread guides?

A. The thread boards are placed between the spindles and the rollers, and each board has screwed into it a wire thread guide, through which the yarn passes on its way from the rollers to the spindles. The guide should be made from about 8's wire, and set with its centre over that of the spindle. Each thread board can be independently turned up for piecing-up purposes, while all the thread boards on both sides of the frame can be turned up simultaneously by a suitable arrangement of levers.

Q. Compare the speed of the traveller with that of the spindle and bobbin.

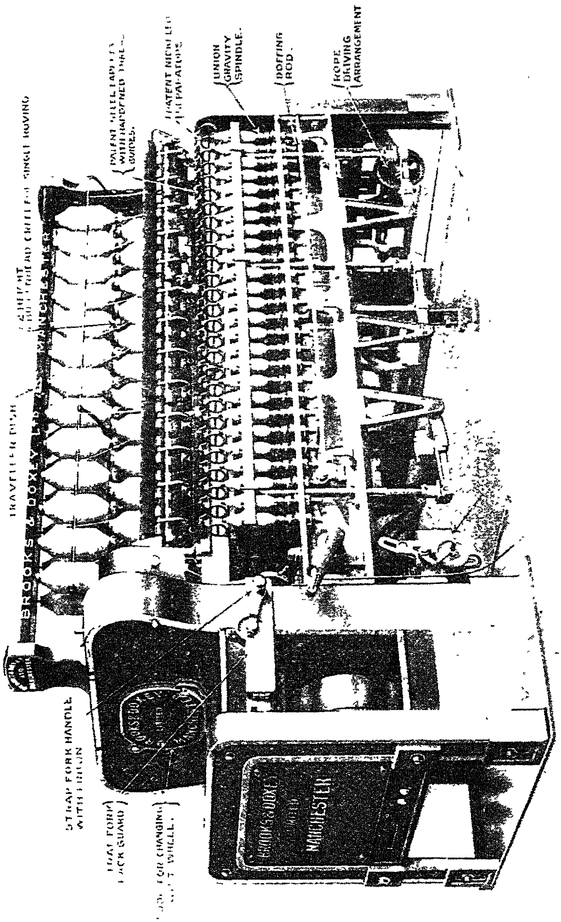


FIG. 87A.—Ring-frame. General view.

A. The traveller always makes fewer revolutions than the spindle, and its speed is always varying, while that of the

spindle or the bobbin is constant. The larger the diameter of the bobbin the quicker the motion of the traveller. This leads to a slight variation in the twist per inch, which, however, only reaches about two per cent. in extreme cases, and this can scarcely be detected by even a minute examination. It may be added that by the difference in speeds between bobbin and traveller winding is performed.

Q. In ring-frames sometimes one tin roller is used and sometimes two tin rollers. Taking the double cylinder method, explain the method of driving the second cylinder, and describe an apparatus for rendering assistance in this respect.

A. In the double cylinder method the second cylinder is usually driven by the frictional contact of the spindle bands,

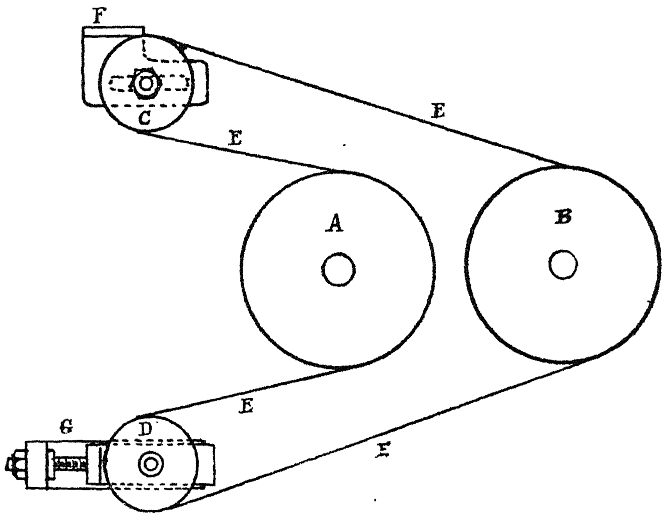


FIG. 88.

which are operated by the first or pulley cylinder. In this way the spindle bands are kept nicely in the bottom of the spindle wharves.

Some people consider that this method leads to a loss of twist on the indirectly driven side, besides imposing double work on the spindle bands operated by the first tin cylinder.

To remedy these defects methods have been devised for driving the second tin cylinder from the first by wheels, which, however, have been discarded on account of noisiness and breakages.

Various systems of supplementary driving of the second cylinder by ropes have, however, received more extended adoption.

One arrangement is shown in Fig. 88, where A, B, are the rope pulleys on the two tin cylinders; C, D, serve the double purpose of guide and tensioning pulleys, being adjustably held by the brackets, F, G; E is, of course, the rope.

It is the author's experience that the loss of twist on the negative or second side, and the increased breakage of spindle bands, are not really very serious, while the rope-driving

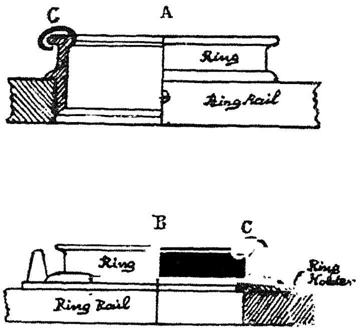


FIG. 88A.

method makes the frame heavier to drive, and gives a great deal of trouble to the overlookers and jobbers, by frequent breakages and entanglement with the spindle bands. In the case of yarn of high quality and strength, such as thread-yarn, the rope-drive may be recommended.

Q. 1898. What is the construction of single and double rings used in spinning? How are they respectively fixed to the rails? Illustrate this by a sketch.

A. The more usual construction of the rings is to have a single ring with a thin flange at the top for the small traveller to revolve upon, while a second flange, a little lower down, rests upon the ring rail. Below this there is formed a special surface which enters and fits into a circular aperture in the

ring rail. A very small screw passes through the ring rail and holds the ring firmly in its position, although each ring should be a good fit in its aperture with the screws. In a special form of double ring there are duplicate flanges for the traveller to work upon, and the rings are reversible. The flanges are at the top and bottom of the ring, and this arrangement necessitates a special method of fastening.

Referring to Fig. 88A, at A is the single ring, and at B the double ring, C being the traveller in each case. The sketches are self-explanatory. Split holders are often used for double rings.

While in England the single ring is by far more used, in America the double ring meets with considerable favour.

Q. 1898. By what means is the traverse of a ring rail obtained, and what part of the mechanism determines its relative velocity at various periods of the traverse?

A. The traverse of a ring rail is obtained primarily from a specially shaped cam placed at the end of the frame, and constantly rotated in one direction. This presses the "copping lever" down, the fulcrum being at one end of the lever, and the copping chains, etc., being connected to the opposite end of the lever. The downward movement of the "copping lever" thus obtained is communicated to the ring rail by rods, levers and chains, so as to usually move the rail upwards. The bowl of the "copping lever" is kept constantly pressing against the cam by the weight of the parts, assisted by specially placed and adjustable weights, so that when the thin part of the cam is presented to the bowl the latter follows it, and the ring rails descend. The cam is so designed that the movement of the ring rails in one direction is performed in about one-fourth the time occupied by the total up and down traverse. In some cases the descent of the rails is more rapid than the ascent, while in other cases the opposite holds good. Illustrations of the copping motion are given in Figs. 90, 91, 92.

Q. 1897. For what reason is a traveller of a certain weight selected in spinning any given counts of yarn? Is it ever necessary to change the weight of the traveller if the counts spun are constant, and why?

A. It is necessary to select a traveller of a given weight in order to get the best possible results in winding, much as

it is necessary to correctly weight the counter-fallers of a mule. If the traveller be too heavy, the strain imposed upon the yarn in dragging the traveller round will be unnecessarily increased, and the threads will be broken. On the other hand, if the travellers be too light, ballooning will be increased to a great extent, and the bobbins will not be wound as hard and as nicely. An evenly-balanced traveller is a great deal towards securing evenly-balanced winding and twisting, and the correct grading of the traveller is, without doubt, one of the most important points requiring the attention of the ringmaster.

It is sometimes necessary to vary the traveller even when the same counts are spun, although this is somewhat unusual, as it is a fundamental principle that the finer the counts the lighter should the traveller be. This point, however, is somewhat analogous to the variation of the twist on a mule, where the twist or the weight on the counter-faller are sometimes varied when the cotton is a little worse. So we might put on a lighter traveller if the spinning were worse than usual owing to the cotton being worse, or owing to some other cause.

Q. 1897. How is weft yarn spun on a ring-frame? At what angle should the rollers be placed? What are the chief difficulties to be overcome?

A. The usual way of spinning twist yarns on a ring-frame is to have the yarn placed on bobbins or spools. These, however, would be inconvenient for the shuttles of the loom in the case of weft yarns, for a great many sorts of cloth, in which an extremely large shuttle cannot be used. For this reason weft yarn on the ring-frame is frequently spun upon paper tubes or pirns. Very numerous attempts have been made, and are now being made, to overcome the difficulties in the way of spinning yarn on the bare spindle, as this would be a great boon, for wefts especially. These difficulties consist chiefly in the fact that a great strain is put upon the yarn when winding upon a very small diameter like a bare spindle; and also at the same time there is a variation in twist, which always gives the least twist when winding on the smallest diameter. Most inventors seem to have gone on the lines of producing a special form of traveller in which the strain of the thread is minimised, on account of the traveller not being pulled as strongly against the edges of the ring.

There is very great difficulty experienced in getting good noses on cops spun upon the bare spindle of the ring-frame, and consequently the cops will not "ready" very well. The angle of the rollers for weft may be about 35° to the horizontal, the object of the inclination, of course, being to allow the twist to run right up to the nip of the rollers.

It may be added that the angle of the rollers on a ring-frame varies from, say, 15° to 35°, although about 25° is probably the most common. Cases exist where even the limits just given are exceeded. At the 1900 Paris Exhibition the author examined a ring-frame designed to spin on the bare spindle with the rollers inclined at probably 55° or more. The most usual method of spinning weft yarns upon the ring-frame is to do it on thin wooden pirns or on long paper-tubes.

Q. The production of ring-spinning mills is largely delivered to manufacturers in the shape of ring warps. Give one reason showing that this mode of disposing of ring yarn is advantageous to the spinner, and another why it is beneficial to the manufacturer.

A. Ring-spun warp yarn is almost invariably wound upon wooden bobbins or tubes. If the yarn is sold in this form a considerable expense is entailed in connection with the transit of the bobbins of wood, or other material, and this is saved to the spinner when he sells his yarn in warp yarn.

As regards the manufacturer, the trouble and expense, and the loss by waste involved in winding and warping, are saved to him.

Q. Define the position and office of the following parts of a ring-frame: Heart cam, traveller, poker bar, ring rail and builder wheel.

A. (1) The cam referred to is at the end of the frame, and its use is to depress the long copping lever and thus raise the ring rails, the latter being depressed by their own weight.

(2) The traveller is a principal factor in the twisting and winding-on operations and in hardening the cops or bobbins of yarn. It is sprung loosely on the ring and is pulled round by the yarn.

(3) The poker bars are vertical rods which sustain the ring rails, and communicate the motion of the copping apparatus to the ring rails.

(4) The ring rails sustain all the rings, in the centre of which are the spindles, and round which the travellers are dragged by the yarn. They rest on the poker bars.

(5) The builder wheel is part of the copping motion at the frame end. By its gradual movement the cops or bobbins are lengthened, and by its size the diameter of the cop is determined.

Q. 1900. What are the features which fix the gauge of spindles in a ring spinning machine? Are there any appliances which enable the gauge of spindle to be made less, and if so, how are they constructed, and how do they act?

A. The principal determining point as regards the gauge of spindle is on this machine as on all others, the size and diameter of cop or bobbin to be made. A second important determining factor is that the spindles must be a sufficient distance apart to prevent contiguous threads from catching each other by ballooning. There is an appliance which enables the gauge of spindles to be made somewhat less, and this is the anti-ballooning appliance. In one arrangement there is a highly polished flat metal plate running the full length of the frame, and having, as it were, fingers projecting in between each pair of rings. The fingers prevent and limit ballooning so that adjoining threads cannot touch each other. Ballooning is worst in the earlier stages of building the cops or bobbins, and is so small when the bobbins are getting nearly full size that it is common to have the anti-ballooning appliance put out of action at this stage until after doffing. In later forms of anti-ballooning appliances—termed more particularly separators—the metal plates are disposed vertically between the spindles. In some cases there is simply a wire running behind the spindles.

Q. 1896. What useful purpose is served by the balloon in ring spinning? How is it formed? Describe and sketch any appliance which is used to check it.

A. The useful purpose served by having a certain amount of ballooning is that a somewhat lighter traveller can be used, which means that less strain is put on the yarn. Between the guide wire in the thread board and the ring rail there are several inches of yarn; a greater length when the ring rail is at the bottom of its traverse, and a less length when the rail is at the top of its traverse. The quick revolution of the

spindle and bobbin causes this length of yarn to fly outwards, or "balloon," and obviously if this ballooning is carried too far adjoining threads will come into contact and cause a large amount of breakages of the yarn. It is probable that this ballooning could only be absolutely stopped by using very heavy travellers, and thus breaking the yarn by subjecting it to an undue strain. But a fair amount of ballooning can be allowed with impunity, and it is therefore better to adopt a medium course, and allow ballooning to some extent. Various patents have been devised for restricting the amount of ballooning. They usually consist of some simple appliance or guard, so placed that the yarn in flying outward impinges against the guard, and is thus limited in its ballooning tendency.

Many frames have a length of wire running behind the spindles, which is readily adjustable, so as to allow of the ballooning to be limited to the exact extent desired. Messrs. Dobson & Barlow employ a light plate, which is open at the front of every spindle, but which surrounds every spindle on the other three sides. Ballooning is limited on some frames by the guide wire on the thread boards being brought much nearer to the spindle tops than formerly. The writer is acquainted with frames which never use the balloon preventor, although it forms part of the frame. In these cases the cotton and the counts are seldom varied, and a certain weight of traveller has been proved to be quite sufficient for limiting ballooning, without at the same time causing the ends to break. It is quite common to spin 60's twist from Egyptian cotton without using any separator or wire.

Anti-Ballooning Arrangement.

The anti-ballooning device shown in the three views included in Fig. 89 is of the type which is characterised by a hinged or pivoted rail, upon which are arranged horizontally, between the cops, a set of fingers or forks. Each of these, as the cops approach completion, is tilted out of the way for doffing. The ballooning fingers, A, are mounted upon a rail or angle iron bar, B, which extends from end to end of the frame and is supported at intervals by adjustable brackets, the latter having cast on them projecting lugs, D, and pivots, C.

The pivots work in vertical slots, E, cast in the brackets, F, the latter being bolted on the front of the roller beam, G. Each bracket is formed with a slot, to receive a stop-piece for limiting the radial movement of the rail when titled backwards or forwards. The fingers are of the form shown, and the rail upon which they are mounted is in sections to take in about sixteen fingers. When a new set of bobbins is started the

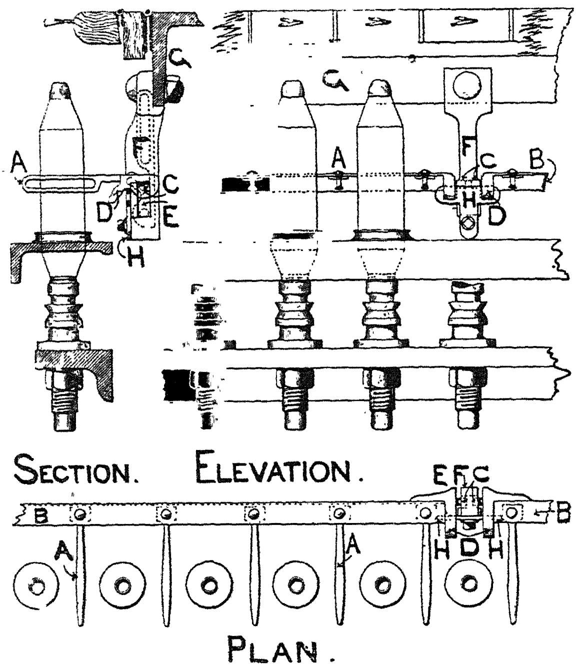


FIG. 89.

fingers are brought to about midway of the lift; and as the building proceeds the fingers are tilted out of the way gradually until they pass the perpendicular position, whereupon they fall by gravitation out of the way, and allow of the doffing being proceeded with.

At the commencement of the bobbins, as stated, the fingers stand in a horizontal position about half-way of the lift, and

resting on the movable projection, H, on the bracket, F, with the pivot at the top of the slot, the latter thus forming a stop for the fingers when in this position.

As the building of the cop advances the ring rail comes in contact with the fingers and forces them upwards.

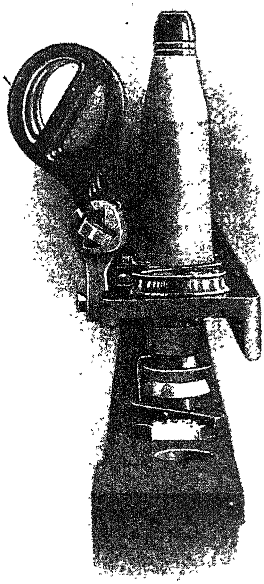


FIG. 89A.—Blinker separator.

When they are raised to a certain point the weight of the parts A, B, together with the shape of the special lug, D, riding over the projection, H, overbalances them, and the whole combination drops into a vertical position, as shown in dotted lines in the section. The pivots, C, are then resting at the bottom of the slot, E, and the fingers have fallen quite

clear of the spindles and bobbins, and are lying quite close to the roller beam, although clear of the thread boards. After doffing, a very slight touch with the fingers is sufficient to replace the apparatus in working position.

Makers recommend the adoption of the following gauges and sizes of rings for the ranges of counts stated :—

4's to 20's counts,	$2\frac{5}{8}$ inch gauge,	$1\frac{3}{4}$ inch ring.
20's to 40's ,,	$2\frac{1}{2}$,,	$1\frac{5}{8}$,,
40's and upwards	$2\frac{3}{8}$,,	$1\frac{1}{2}$,,

Q. 1900. Describe the building mechanism of a ring spinning frame on bobbins, and show how the bobbin is built.

A. It is customary to operate the building motion from a worm or a bevel-wheel on the axis of one of the wheels at the gearing end of the machine which are concerned in driving the rollers.

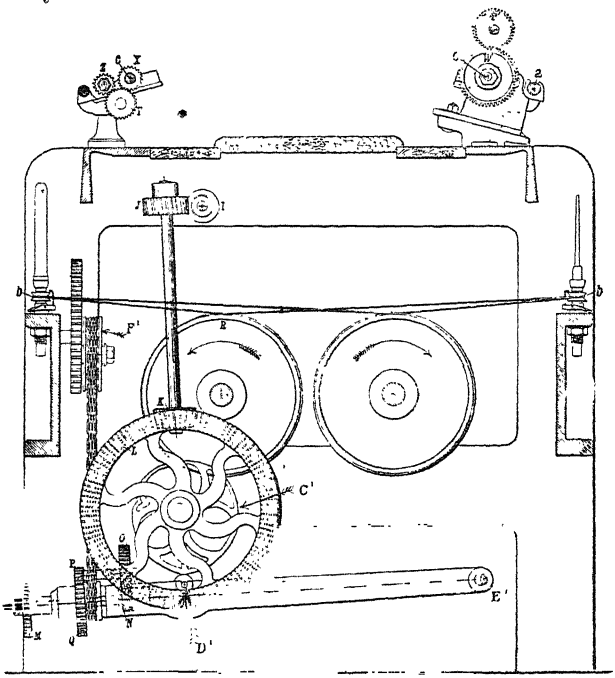
This gives motion to an almost upright shaft, which reaches downwards and carries a worm at its lower extremity which drives the cam-shaft wheel. The cam being on the same axis is kept continually rotating, and pushes the copping lever down, while the copping lever is kept pressing against the cam by the weight of the parts, and follows it back again, when the thin or falling part of the cam again comes round. The copping lever is connected by rods, chains and levers and the pokers to the ring rails in such a manner that the downward motion of the copping lever is accompanied by the upward motion of the ring rails on each side of the frame, and *vice versa*.

On one of the chain bowls there is an adjustable snug or lip which comes into operation only during the earlier building of the set of bobbins. It then prevents the ring rail from dropping as low as it otherwise would do, and so shortens the chase. The gradual disuse of this snug allows the chase to lengthen, and the two cones of the bobbins to be thus formed.

Forming part of the building motion is the shaper wheel and connected parts, and the slow rotation of this gradually causes the lift of the ring rail to be made over a higher portion of the bobbin, thus forming the body of the latter. The higher the number of teeth in the builder wheel the larger will be the diameter of the bobbins.

Referring to Fig. 90, the worm, I, gives motion to worm

wheel, J. On the lower extremity of the same shaft is the bevel, K, gearing with and driving the larger bevel, L. On the same stud as L, and therefore rotating with it, is the cam, C′. As the cam, C′, rotates its full part, acting on the stud, D′, depresses the lever, M, E′, working on the fulcrum, E′.



RING FRAME

FIG. 90.

This pulls the chain shown from the bowl, P′, and forward from this is a connection by which the pokers and the lifter rails are raised. The weight of the parts compels lever, M, E′, to follow the cam when the latter presents its thin side to the lever, thus bringing about the downward motion of the ring rails.[1] At M is the shaper wheel by which the

[1] See note on connections from cam to ring rails in new section ring-frame.

chain shown is gradually wound round the bowl near to Q, P, and the shortening of this chain is followed by the gradual building of the cops higher up the spindles, since the greater the amount of this chain unwound from the bowl at Q, P, the lower may the ring rails descend. The minimum amount of chain is unwound, for full bobbins, and the maximum amount for empty bobbins from the bowl Q, P.

Q. 1896. What is the production in hanks, per week of fifty-six and a half hours, of a mule and ring-frame respectively, spinning 40's twist? Is one larger than the other, and why? Compare the turns per inch given in each case.

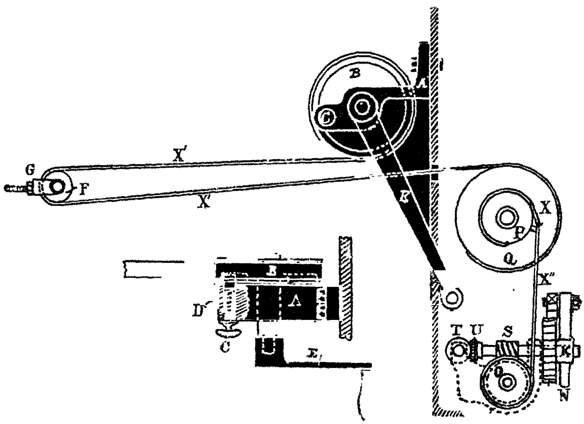
A. If fifty tests of actual productions were made at fifty different mills we might expect them all to differ more or less from each other. We can, however, easily give productions which might be taken as representing something like an average.

In a mill using a fair quality of American cotton we might reasonably expect good modern mules to turn off about thirty hanks of 40's twist in an ordinary working week of fifty-six and a half hours.

In the same mill, and from the same cotton, we should expect the ring-frames to turn off somewhat more per spindle of the same counts, say, about thirty-six hanks per spindle. This, of course, is on account of the ring-frame being a continuous spinner, whereas the mule is an intermittent spinner, and loses time during backing-off and winding-on. In some cases the superiority in production is more manifest than as given above, whilst in other actual tests the productions of the mule and ring are almost equal. As a rule the twist per inch put into the yarn is rather more on the ring-frame than the mule. Often for the yarn on the ring-frame the square root of the counts is multiplied by the constant number four, whilst for the mule twist the square root of the counts is multiplied by 3·75. Thus for 40's ring yarn we get $6 \cdot 32 \times 4 = 25 \cdot 28$ turns per inch, and for 40's mule twist we get $6 \cdot 32 \times 3 \cdot 75 = 23 \cdot 7$. It must not be supposed that the advantages are all on the side of ring spinning because of the latter's superiority over the mule in point of production. The disadvantages of having to wind the yarn chiefly on spools or bobbins, and being awkward to spin tender yarns, are serious drawbacks to the ring system.

Q. 1899. Describe fully the method of doffing a ring-frame, detailing the mechanical apparatus necessary. How is the frame restarted?

A. To doff a ring-frame it is necessary (1) to have doffers and empty bobbins and bobbin skips ready. (2) During the down movement of the ring rail wind the rail to the bottom, and at the same instant stop the frame. (3) Put the thread boards out of the way. (4) Remove the full bobbins and put on the empty bobbins, and then put down the thread boards. (5) Start the frame, and at the same time hold the ring rail up for an instant. It is necessary to connect a handle and



FIGS. 91 and 92.

other parts to the copping mechanism to provide for winding down. It is also necessary to provide a lever arrangement for holding the rail up for an instant when the frame is restarted.

An excellent arrangement is shown in Figs. 91 and 92.

During the working of the frame the peg or stud, C, is held by the spring, D, firmly in an aperture provided in the boss or chain roller, B. When it is required to doff, the stud C is withdrawn from B, and the attendant then allows the ring rail to fall to the bottom, but steadying and guiding the motion by means of the long handle, E, specially provided for the purpose. It is usual to do this work when the ring

rail is moving downwards and the weight of the parts is sufficient to secure the quick downward motion, when the pin. C, is released, and to unwind the chain, X′, from the boss or roller, B.

Copping Motion.

The same sketches will serve to illustrate a word or two about the copping arrangement. The catch fulcrumed at K moves the builder wheel, N, and thus rotates the worm, S, and therefore the worm wheel, O. To the same stud as the latter is secured a chain roller, round which the chain, X″, is thus slowly wrapped, and at the same time pulled off the chain roller at P. The rotation of P winds the chain X′, upon Q, and thus the ring rail is gradually prevented from descending as far as the cops or bobbins increase in size. The parts, T, U, are connected with the handle for winding the shaper to its initial position when doffing. At X is the snug for shaping the bottom cones of the bobbins.

Q. How many turns per inch will be put up in the yarn on a ring-frame? Tin roller, 30 teeth; twist carrier, 100; twist wheel, 37; front roller, 70; spindle wharf, $\frac{7}{8}$ inch; tin roller, 10 inches; front roller, 1 inch.

A. This problem could be readily worked out in one operation; but it will be clearer to divide it out into three operations, as below:—

(*a*) $\dfrac{37 \times 30}{70 \times 100}$ = ·158 revolutions of front roller to one of tin roller.
= ·496 inches delivered.

(*b*) $\dfrac{10 \times 8}{7}$ = revolutions of spindle to one of tin roller, without accounting for slippage.
= 11·42.

(*c*) $\dfrac{11{\cdot}420}{{\cdot}496}$ = 23·02 turns per inch.[1]

Q. 1899. How does a traveller act during spinning on a

[1] A really correct answer could only be obtained by allowing for the revolutions which the traveller makes less than the spindle, in addition to allowing for slippage of bands.

ring-frame? What effect has it upon the yarn in winding? Give full answer.

A. The action of the traveller during spinning is that it is carried round the ring by the thread, the latter being carried round by the bobbin, which is fast to the spindle. It may be said that the traveller exercises an important effect upon several of the essential functions of the ring-frame: (1) It is the medium by which winding is effected; as the thread issues from the rollers the traveller is graded in weight so as to lag behind the bobbin so as to accomplish the winding-on. (2) Along with the bobbin or spindle it determines the twist put into the yarn. Suppose a bobbin and spindle to make twenty-two revolutions for each inch of thread that came out of the rollers, while the traveller only made twenty-one and a half revolutions, the turns per inch would be twenty-one and a half, so that the revolutions of the traveller, and not of the spindle, equal the turns of twist. A stationary traveller would give the maximum of winding-on, but no twisting. A traveller making the same revolutions as the spindle would give the maximum amount of twisting, but no winding-on. There is some degree of strain imposed on the yarn in pulling the traveller round, especially in the top and bottom of the set. Heavier travellers are put on to give harder bobbins, and sometimes to limit ballooning.

Q. 1896. What is the characteristic feature of a Rabbeth ring spindle, and why is it inferior to a flexible or gravity spindle?

A. The characteristic feature of spindles of the Rabbeth type is that they are entirely self-contained. The Booth-Sawyer spindle, which preceded the Rabbeth, was exceedingly successful, but had the defect of its two bearings—the bolster or top bearing and the footstep or bottom bearing—being fixed in entirely separate rails, which were liable to get out of truth and to disturb the perfect concentricity of the parts so essential in ring spinning. This is not the case with the Rabbeth. Moreover, the Booth-Sawyer spindle had to be oiled every day, whereas the Rabbeth only needs oiling every few weeks. Some ring-masters object to the Rabbeth spindle because a pump is necessary to pump all the dirty oil out of the footsteps at intervals. There are many makes of spindle which are modifications of the Rabbeth spindle, in which a round cup at the bottom can be easily

taken off and the dirty oil emptied without the necessity of using a pump. The cup used on some frames for fitting the bobbins upon, assists in keeping the bobbins firm and steady during working. The spindle is very readily adjustable, so as to be perfectly concentric with the ring.

Referring to the second part of the question, it may be said that the high speeds now attempted have a strong tendency to impart unsteady running to the spindles. This is aggravated from the fact that a bobbin is imposed upon the spindles, and it is easy to imagine that some of these bobbins will at times get a little out of balance. The Rabbeth spindle cannot make compensation for this. The "Flexible," or "Gravity," or "Elastic" spindles have that valuable property to some extent. This type of spindle, like the Rabbeth, was first introduced in America, and, whilst retaining all the benefits accruing from a long bearing, has a certain amount of play or slackness which will allow it at very high speeds to find its own centre of gravity and revolve with absolute steadiness. There are various types of this spindle, such as the "Whitin," the "Furguslie," the "Simplex," and the "Acme". All these spindles are constructed on the principle that a quickly revolving body, although of slightly uneven balance, will tend to revolve steadily with its axis a little out of the perpendicular. This principle cannot be carried out to such a great extent in ring spinning, and means are adopted by which the variation from the vertical cannot become too great. It is, however, often about $\frac{1}{64}$ inch on the spindle point, and occasionally two or three times this amount.

Ring-Spinning Spindles.

One of the great merits of the Rabbeth, and of spindles made on similar lines, is that it facilitates doffing by obviating the necessity of tieing the ends on to the empty bobbins in commencing a new set. The result is attained in a very simple way. In preparing for removing the full bobbins (whilst the frame is still running) the ring rail is dropped to its lowest position for the commencement of a new set of bobbins, and on stopping the frame and removing the bobbins the yarn coils in a very coarse spiral once or twice round the spindle. When the empty bobbin is put on the end is nipped

in the brass cup as securely as if it were tied, although no special operation has been required. This simple arrangement saves considerable time in doffing.

Some people prefer not to use the brass cup, and in such cases the doffing thread is nipped between the bobbin and the spindle.

The efficiency of the lubrication of this spindle is by long experience proved beyond doubt. Once every six weeks is sufficient for renewal, providing best spindle oil and well-balanced bobbins of the best quality are used, which experience has proved to be very essential.

Howard & Bullough's Flexible Spring Spindle.

The growing tendency of the trade to quicker speeds and increased productions resulted in certain modifications and improvements, and to effectually sustain such speeds this quick-running spindle was invented. It has just recently been improved, and will stand a high speed, even with defectively balanced bobbins, without heating or undue wear. The lower part of the spindle blade fits into a loose bush with suitable provision for continuous lubrication, and this bush rests in the ordinary Rabbeth bolster which contains the oil. A steel bow spring riveted to the top of the loose bush, and pressing in the slot against the inner surface of the bolster, compensates for any oscillation in the spindle due to the bobbin being out of balance, or from any other cause, for the time allowing the spindle and bobbin to find a centre other than their common one, without detriment to either the working parts or the spinning. This has entirely overcome the fatal objection to high speeds in the ordinary non-flexible Rabbeth spindle. The head of the rivet for the bow spring also fits into the slot in the bolster, thus effectually preventing the bush from turning round with the spindle.

The Automatic Spindle Holder

is a valuable improvement, and its action will be understood by a reference to the spindle on the right of Fig. 93. The object of this arrangement is to hold down the spindles when doffing, to prevent their being lifted with the full

bobbins, but at the same time to permit the spindle being easily lifted out for oiling.

In Fig. 93 are shown (5 inch lift) spinning spindles largely adopted, if 6 inch lift they are numbered differently. Spindles should be thoroughly examined and tested before delivery

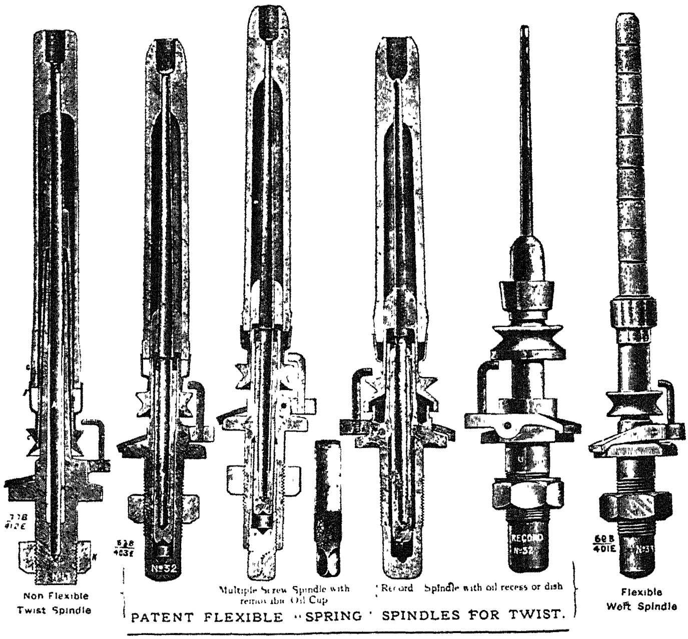


FIG. 93.

under usual and also abnormal working conditions. The essentials of a good spindle are:—

(1) Light running.
(2) Steadiness under high speed.
(3) Simplicity of construction.
(4) Non-liability to get out of order.

PRODUCTION.

With the introduction of the patent flexible spring spindle the speeds and productions have increased considerably over

those of the ordinary Rabbeth spindle. Many people, however still seem to prefer the ordinary Rabbeth. It may be stated that compared for different counts with the production of a mule on the same counts, it will be found that in the lower numbers the production of the ring-frame preponderates over that of the mule, but as the higher numbers are reached the mule becomes more and more on an equality with the ring-frame. The limit of production of the mule in coarse counts is determined by the number of draws per minute the carriage can run at, and as this number is limited it controls the speed of spindles.

The limit of production of the ring-frame for very coarse counts is partly determined by the speed of front roller and the piecing-up capacity of the operatives.

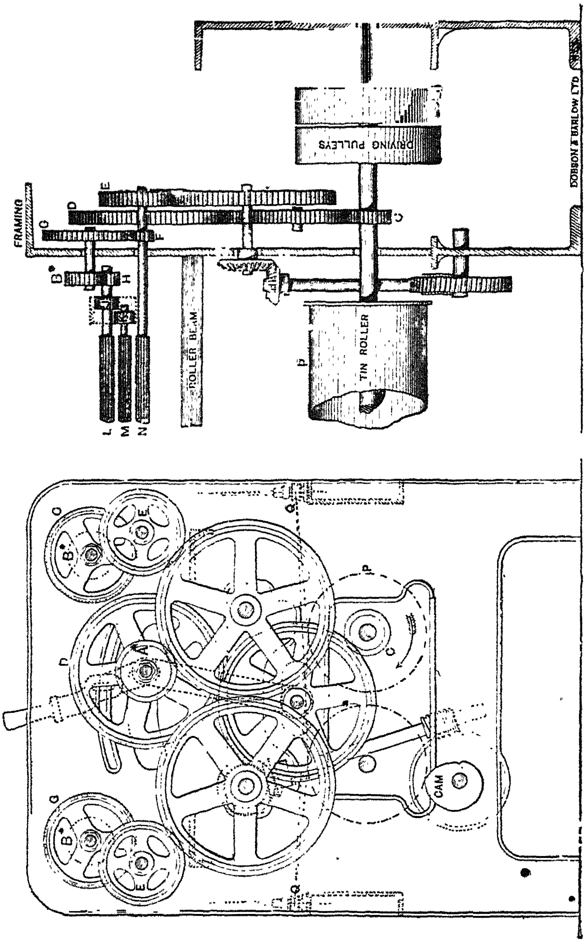
Gearing of Ring-Frame.

In Fig. 94 is shown fully the gearing of the ring-frame as made by Messrs. Dobson & Barlow. (See pages 270-1.)

Q. 1911. Describe the construction of the bobbins as used for ring spinning, and state the essential features which they must possess to obtain the best results. Show, by means of sketches, how they are supported and driven by the spindles during the operation of spinning.

A. The bobbin of a ring-frame is definitely secured to its spindle, and is taken round thereby at the same speed, and no attempt is made to give it any different drive or different speed. It is necessary for the bobbin to fit somewhat tightly to the spindle in order to prevent either slippage or the tendency of the bobbin to work loose and move up the spindle. At the same time it is necessary to be able to readily pluck or pull each bobbin off its spindle for doffing purposes. The best and most used method appears to be for the bobbin to fit the spindle tightly for possibly $\frac{3}{4}$ inch running down from possibly 1 inch from the bobbin top. A tight fit at this point and a slack fit at the sleeve. The use of a cup for the bobbin to fit into is optional. To permit ready winding and unwinding of the yarn the bobbin is usually somewhat tapered towards the apex, and it helps to form the

cones and to fit the spindle sleeve if the bobbin is made a little full at the bottom. If for conditioning in the bobbin then the bobbins should be enamelled. Frequently the bobbin is strengthened by a metal circlet at the bottom. Rings turned in the bobbin keep the yarn on. Sometimes also at the top.



GEARING OF RING FRAME

Fig. 94.

REFERENCES TO GEARING PLAN OR RING SPINNING FRAME.

A* Twist Wheel. Change place 20 to 70 teeth.
B* Draft Wheel. Change place 26 to 60 teeth.
C Tin Roller Wheel.
D Twist Carrier Wheel.
E Front Roller Wheel.
F 20's Front Roller Wheel.
G Crown Wheel.
H Back Roller Wheel.
J Back Roller Wheel driving Middle Roller.
K Middle Roller Wheel.
L Back Roller.
M Middle Roller.
N Front Roller.
P Tin Roller.
Q Spindle Warve.

CALCULATIONS.

$$\text{Speed of Spindle} = \frac{\text{Revs. of P} \times \text{P}}{\text{Q}}$$

$$\text{Revolutions of Front Roller} = \frac{\text{Revs. of C} \times \text{C} \times \text{A}}{\text{D} \times \text{E}}$$

$$\text{Turns of Spindle for one of Front Roller} = \frac{\text{E} \times \text{D} \times \text{P}}{\text{A} \times \text{C} \times \text{Q}}$$

$$\text{Twist per inch} = \frac{\text{E} \times \text{D} \times \text{P}}{\text{A} \times \text{C} \times \text{Q} \times \text{N} \times 3{\cdot}1416}$$

$$\text{Twist Wheel} = \frac{\text{E} \times \text{D} \times \text{P}}{\text{Twist per inch} \times \text{C} \times \text{Q} \times \text{N} \times 3{\cdot}1416}$$

$$\text{Constant Number for Twist} = \frac{\text{E} \times \text{D} \times \text{P}}{\text{C} \times \text{Q} \times \text{N} \times 3{\cdot}1416}$$

$$\text{Twist Wheel} = \frac{\text{Constant Number}}{\text{Twist per inch}}$$

$$\text{Twist per inch} = \frac{\text{Constant Number}}{\text{Twist Wheel}}$$

$$\text{Draft} = \frac{\text{H} \times \text{G} \times \text{N}}{\text{B} \times \text{F} \times \text{L}}$$

$$\text{Draft Wheel} = \frac{\text{H} \times \text{G} \times \text{N}}{\text{Draft} \times \text{F} \times \text{L}}$$

$$\text{Constant Number for Draft} = \frac{\text{H} \times \text{G} \times \text{N}}{\text{F} \times \text{L}}$$

$$\text{Draft} = \frac{\text{Constant Number}}{\text{Draft Wheel}}$$

$$\text{Draft Wheel} = \frac{\text{Constant Number}}{\text{Draft}}$$

Birch is much used for cardroom bobbins and sometimes for ring bobbins. Ash, Beech, and Birch are used for

skewers for different machines. For ring-doubler bobbins large quantities of rock-maple and some sycamore are used. Skewers are mostly tipped with box at the foot and brass, iron or porcelain have not met with much success as tips.

Centrifugal clutch spindles are now sometimes employed, the spindle sleeve being made in hinged sections which expand and grip the bobbin when the spindle attains speed.

Q. 1911. Describe the means used on a ring-frame for guiding the ring rail during its movement so as to preserve the concentricity between the rings and the spindles. If at any period of the lift this condition is not maintained, what would you expect to result, and why?

A. The ring rails are made in short lengths to prevent deflection. They are secured to the lifting pokers by special milled heads, which have a good grip on the ring rails to prevent vibration during working. Frame ends and spring pieces are made with loose feet for adjustment to suit uneven flooring, so that each frame gets a steadiness which is conducive to easy working of lifter parts. The pokers or vertical lifting rods which connect the ring rails with the copping levers work in long cast-iron tubes which are set in a vertical position by means of adjustable brackets on the girder spindle rail, and this prevents any tendency of the rails to bind at the top or bottom of the lift. The use of these long cast-iron tubes, combined with initial concentric adjustment of spindles to rings, and strength and steadiness of connected parts, help to maintain the condition required. If any period of the lift, the concentricity of spindle and ring be not maintained, there is a variable and excessive strain imposed on the thread in dragging the traveller round, inevitably leading to bad spinning.

Q. Sketch and describe the method of connecting the cop-shaping mechanism to the ring rails of a ring-frame.

Connection of Copping Motion to Ring-rails. Fig. 95.

A. The depression of the long copping lever draws one chain off the bowl C and winds a second chain E upon the bowl D, chain E thus pulls at arm F of crank lever F, J, working on shaft I_2. The bottom chain H connects to a second shaft I,

these shafts reach across the frame transversely, and there are as many of them connected together by chains and rods as may be required for the length of the frame. It is clear that the pull of the strong first chain E will lift the vertical pokers L_1L_1, which rest firmly but loosely upon the bowls

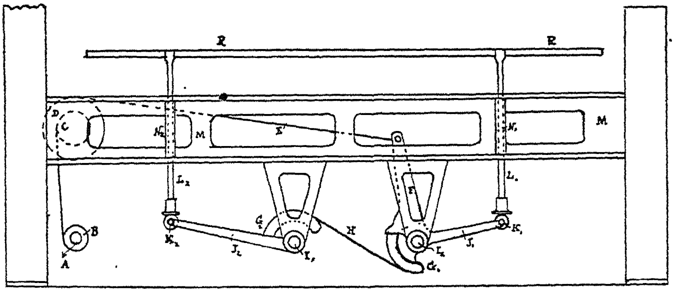


FIG. 95.

K_1K_1, and are kept in position by the vertical bearings N_1N_1. The ring rails are fitted accurately and firmly in sections upon the tops of the pokers, but can be easily lifted off if required. The return of chain E permits the ring-rails to drop by their own weight.

Q. Explain how twist may be temporarily lost during spinning on a ring-frame and then regained during unwinding at the next process.

WINDING AND UNWINDING TWIST.

A. Winding-on of the yarn at the ring-frame is accomplished by the traveller having fewer revolutions than the bobbin or spindle. In making the yarn every revolution lost by the traveller represents the loss of one twist in the yarn and this explains why the yarn is slightly less twisted when winding upon small diameters than when winding upon larger diameters.

The point to be noted just here is this:—Every coil of yarn wound on, only represents the loss of a twist when the yarn is afterwards unwound from the side of the bobbin. If the yarn is drawn over the nose or apex of the cop or bobbin

the twists are all recovered in the same proportion as lost during spinning and a uniformly twisted yarn results.

Q. Explain very briefly how a ring-frame may be driven at varying speeds.

Variable Driving at the Ring-frame.

A. In some motor driven ring-frames a connection is made from the copping motion to the motor so that the motor gives a quicker speed to the frame when winding on the larger diameters of bobbin than for the smaller diameters of bobbin, since thread-breaking is more likely to occur on the smaller diameters. The Brown-Boverie frame is well known in this connection.

In some other cases a two-speed drive is arranged, or else cone driving, so that the frame can be run slower for some little time after doffing, than after the frame has got going properly.

Q. Explain how the shaper wheel or builder wheel of a ring-frame is driven, what conditions rule its size, and the connection of the twist wheel to the copping motion.

The Shaper Wheel.

A. A so-called larger shaper or builder wheel is used for finer yarns or to obtain thicker cops or bobbins in producing the ordinary cop build of bobbin.

A larger shaper wheel means one with more teeth either at the ring-frame, mule, or fly-frame, but the diameter of wheel remains the same at any particular machine whatever the number of teeth. A wheel of 40 teeth at the ring-frame is the same diameter as a shaper wheel of 20 teeth, but the pitch of the tooth in the 20 is twice that in the 40 wheel, and as each is moved one tooth for each double lifter traverse it follows that the building rate is twice as quick for the 20's wheel as it is for the 40's.

It is arranged for the long lever of the building motion, and therefore for the lifter to be really moved through the medium of the twist wheel, so that a larger twist wheel not only speeds up the rollers and delivers the yarn more quickly

but also proportionally quickens the lifter to keep the yarn coils at the correct pitch.

Q. What rule would you follow in changing counts of yarn on a ring-frame in regard to the Builder Wheel? Give an example.

A. There are many rules for determining the proper size of builder wheel when changing counts, but the following is perhaps the most generally applicable and the most likely to give good average results. First obtain the answer working by simple proportion; second, then obtain the answer by square root; third, add the two answers together and divide by 2. As an example, assume we are now spinning 30's with a 36 builder wheel, and desire to find the wheel for 20's. A wheel of the same diameter, but containing fewer teeth, will be required.

$$(1)\quad \frac{20 \times 36}{30} = a$$

$$(2)\quad \frac{\sqrt{20} \times 36}{\sqrt{30}} = b$$

$$(3)\quad \frac{a + b}{2} = \text{wheel required for the 20's.}$$

Q. What are Crackers in ring yarn? Describe possible causes and remedies.

CRACKERS.

A. The term "cracker" in cotton yarn does not convey the same meaning to every person who uses it or hears it. In many cases it is understood to mean thin or cut places in the yarn, as, for example, in a mule which is unlocking too late it is common enough for scores of threads at the out ends of some mules to show a line of cut or partially broken places. Almost 20 years there was a prolonged discussion upon this very question, and divergent views were expressed in regard to crackers in cotton yarn. In ring-frame yarn, the term cracker is often applied to small doubled places in the yarn or to very small pin-head snarls, which will pull out with a kind of cracking noise. Probably these crackers are more often found in ring-frame yarn spun from Egyptian cotton than in the shorter American cotton. It

has frequently happened that opening the middle rollers further from the front rollers has proved a remedy for crackers when a comparatively long staple of cotton has been used. In other cases a great improvement has been effected by renewing the leather coverings of the top rollers, or re-varnishing the rollers or increasing the weight on the top rollers. It is probable that frames with only a moderate amount of angle and with spindles a reasonable distance in front of the rollers will be less liable to produce crackers in the yarn than the opposite practice. In a general way anything that will produce more perfect drafting and surer working of the top rollers will help to prevent crackers. If rollers are set too near for the length of fibre there may be a tendency to interfere with the easy and true revolution of the rollers when bunches of long fibre come under the action of the rollers, and hence the remedies suggested above. In the case of just slowly working a frame or just starting it there may be a slight hesitancy in the winding on of the yarn as compared with delivery, and hence the tendency to run into pin-head snarls. The term cracker is sometimes applied to the small thick places in yarn caused by bunches of short fibre twisting round the longer fibre when the two are mixed together.

Q. Describe the operation of scouring a ring-frame.

Scouring.

A. What is termed "scouring" or taking the rollers to pieces and giving a thorough cleaning, oiling, and examination of working parts, takes place in many cases about every six months. Some go further than this between scouring times, while there are other firms at which scouring occurs every four months. The practice of uncoupling steel rollers at every scouring time has greatly diminished during recent years for any machines in a spinning mill, but in any cases the steel rollers should receive a very good cleaning, all dirt particles got out of the flutes and any rough places smoothed over. Many people use card clothing for these rollers, while in some cases a stiff brush is used for the purpose. Specially bad rollers might be rubbed with whitening or French chalk.

The necks of the steel rollers should be neatly tallowed at

every scouring time, although this should not be considered an absolute substitute for oiling, but only an assistant thereto. The use of iron pickers or hitting of roller laps with cleaners to help to break them off, undoubtedly tend to lacerate the steel rollers more or less, the evil results showing up most strongly after a few years of such treatment. When it is considered that rollers have suffered in this respect it may pay to have them well rubbed with pumice stone—a well-known remedy used more or less for many years past. While a thorough overhauling and cleaning of all parts of the rollers forms the more common and obvious item in connection with scouring, it is well if various little adjustments can be made at the same time, but, of course, scouring is a very different thing from a general overhauling and resetting of the parts. New frames ought to be scoured after several weeks of running and all bearings wiped out, while if the steel rollers have given trouble with fibre sticking thereto or excessive roller laps they may be rubbed with a mixture of oil and whitening, cleaned with card fillet, and afterwards well rubbed with clean cloths or clean yarn waste.

Q. Is weft yarn ever spun on the ring-frame? What procedure would you adopt in doing this?

Weft on Ring-frames.

A. Speaking generally, shuttle weft spun upon the ring-frame may require a good deal more attention than warp yarn, because it is usually spun softer, and often from worse cotton. To meet these circumstances it may be wise to draft the more skilful of the operatives to the weft frames, and pay more attention to heating, ventilating, and humidifying. Better cotton will, of course, readily make itself manifest in the spinning, but it may not pay a master to go too far in this direction. The tendency of recent years has been for the better qualities or "points on" of American cotton to become dearer and more difficult to obtain. It is more difficult on a ring-frame than on a mule to allow for variations in staple of cotton and in atmospherical conditions; and the general use of female labour for ring-frames as compared with male labour for mules is not in favour of producing ring-frame yarn from poor cotton and low twists per inch. It would appear that many weaving, printing, and dyeing establishments have

adapted themselves to working with harder twisted wefts than formerly, and this, of course, makes it somewhat easier to produce ring-frame wefts.

Using rings of small diameter and paper tubes or wood pirns as large in diameter as the circumstances will permit, is one of the most effective methods of obtaining reasonably good spinning on weft frames, but has the very serious objection of not allowing sufficient yarn to be put upon any one cop or bobbin. It is, of course, well known that with a comparatively great difference in diameter between the ring and the empty tube there is too much strain imposed upon the yarn in the latter dragging the traveller round the ring, and patented forms of traveller to diminish this evil have apparently met with little success although invented and experimented with by the dozen.

Q. Briefly describe the operation of pumping the old oil from the spindle holders of a ring-frame.

Pumping.

A. Previous to pumping Rabbeth spindles be sure to have the roller beam cleaned down so as to prevent the flus or fly adhering to the spindles. The proper time for pumping the spindles is when the bobbins are half to three-quarters filled with yarn. Push the bands off below the wharve. Loose the yarn off the traveller by making a noose in the yarn, and then loop beneath the traveller. Slide the thread boards on one side. Lift each spindle and bobbin together clear out of bolster with one hand, then with the other hand wipe the old oil off the spindle and place it on roller beam. Lift two or three ring rails off carefully, so as to prevent the oil from flying on the rings. Be sure you don't lift any more off at one time. Place the pump in the bolster and commence the operation of pumping; empty the pump out every 40 or 48 Rabbeth spindles. Refill with oil of a tried and approved kind. Replace the ring rails on the pokers. Take three more and continue as before. Put each spindle back into its own bolster; put spindle bands and thread wires into position.

Q. Briefly describe the method of oiling the spindles of a ring-frame.

Oiling the Spindles of a Ring-frame.

A. It is usual to construct the spindle holder so that several weeks may often elapse between oiling times. Frequently also a removable oil cup is fitted to the bottom of each spindle so that the cup can be quickly removed, emptied of the old and dirty oil, and fresh oil put in. In very many cases, however, it is necessary to pump out the dirty oil by means of a specially constructed pump. The proper time for oiling the spindles is when the bobbins are half or three-quarters full. Stop the frame as the ring rails are descending. The following instructions to be carried out just as arranged:—Put the bands off below the wharve. Lift the ring rails to the top of the bobbins by the rack handle or quadrant, the same as when starting the frame, and keep the ring rails in that position by placing the key which is used for the ratchet wheel between the teeth. Slide the thread boards on one side the same as when you prepare for doffing. Commence the operation of oiling by lifting each bobbin and spindle together clear out of the bolster with one hand, pour into the bolster a sufficient quantity of oil with the other hand, and then put the spindle back into its former place. When all the spindles have been oiled, slide the thread rails down until they rest on the catch, replace the spindle bands on the wharve, and then start the frame.

Q. Describe what is meant by traversing thread rails.

Traversing Thread Rails.

A. A device which has met with a very moderate amount of acceptance is that for traversing the thread rails up and down with the lifter; there are several vertical rods or pokers reaching down from the thread rails to the lifting levers connected with the cross shafts of the lifter. These thread rail pokers, however, are sustained nearer to the fulcrum of each lifting lever than are the ordinary ring-rail pokers, so that the thread rails only receive a moderate amount of lifting. As the ring rails lift, so also do the thread rails, but to a much less extent, with the result that the portion of thread extending between the thread wire and the traveller does not vary in length as much as it does with stationary thread

rails, when winding on the bottom of the chase as compared with the top. Granting that the chase of a weft cop, that is, length of top cone, equals $1\frac{1}{2}$ inches, the thread rails might be lifted about half of that distance.

Q. What special method has been recently devised for holding a ring-frame bobbin firmly during working but loosely when the frame is stopped?

Clutch Spindles.

A. In some cases spindles are made with the special object of holding bobbins firmly whilst the frame is working and yet leaving the bobbins free and easy to pull off when the frame or any rate the spindle is stopped.

Each spindle sleeve over which the lower end of the bobbin is placed may be composed of a number of segments and arranged so that their upper portions may fly outwards or expand due to centrifugal force when the spindle attains sufficient speed.

The expansion of the segments gives a firm grip on the bobbins, which loosens away again when the spindle stops.

With the ordinary bobbins—still far and away most in use—a good deal of force is often necessary to pluck a bobbin from the spindle.

Q. 1913. State the functions of the thread wires or lappets of a ring-frame, and show by means of sketches their position relative to the spindle. Describe fully how the spindle is affected by this position, and what results if it is not maintained.

A. The thread wires serve the important function of guiding and holding the threads immediately above the tops of the bobbins. In this way the thread wire plays a valuable part in keeping the thread in a proper path sufficiently near being concentric with the spindle and bobbin. If the thread wire is badly adjusted the thread may rub against one side of the bobbin top, and yet be more than clear on the opposite side, with the result of putting a variable strain or pull on the thread in its passage round the bobbin. Each thread board is provided with a hinge for separate lifting for the piecing up or other purpose, while all the thread boards or lappets are hinged to a common centre, so that all may be lifted at the same time for doffing purposes. During recent years

metal thread lappets have become very largely used, being much less likely to warp, become damaged or to lose concentricity with the spindles although the first cost of metal lappets is greater than wood ones. Occasionally moving lappets are used so as to suit the distance from lifter rail better in regard to the up and down movement of the ring rail.

Q. Fully describe various makes of thread rails.

The Thread Boards.

A. During recent years a very great amount of attention has been given to the question of the thread boards, and at the present time there are hundreds and hundreds of ring spinning frames fitted with steel thread rails. The older and more usual construction of thread rail and board has been to make these of hard wood, highly polished, each board being capable of independent lifting for piecing up or other purposes, while mechanism is generally provided by means of which all the thread boards on both sides of the frame can be lifted at one time. Some frames have been equipped with sliding thread boards in preference to lifting ones, but the lifting arrangement is much more in use. There is a separate thread board for each spindle, and a wire thread guide is fitted into each thread board.

There has been a good deal of trouble due to thread boards warping, not sufficiently holding the thread wires, breaking, and generally speaking not giving the best possible results in the actual working of the frames. As a consequence the steel thread rails have come into use, and these are decidedly better in the long run, but the steel rails run a good deal more in first cost than the wood ones. Especially are the iron or steel rails preferable in the case of very hot climates such as in India, owing to the greater tendency for the wood to shrink and twist. In any place or country the metal thread boards are much to be preferred in regard to withstanding rough usage. A well-known arrangement of these in Lancashire is Tytler & Bowker's combination of steel thread rail with hardened thread wires, and serviceable for both ring spinning and ring doubling frames. It is claimed for this that absolutely accurate setting of the thread wire concentric with the ring and spindle may be obtained and re-

tained. This thread rail is arranged so that the adjustment of thread wire and the locking of the same may be done in one operation. The thread wires are positively and firmly held, and it is not easy for the operative to tamper with the adjustments. There can be no doubt that concentricity of the spindle with the ring, and of the thread wire also with the spindle or ring, are very desirable objects to obtain and main-

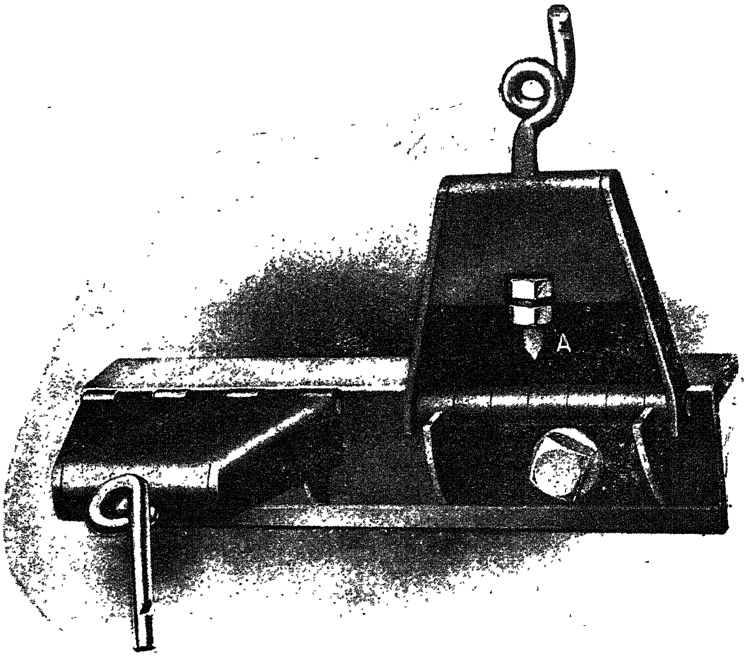


FIG. 96.—Metal Lappet. *Tytler & Bowker's.*

tain, since they help materially towards uniform tensions on the yarn, and prevent the threads from rubbing against the tops of the bobbins at one side, and lying away from the bobbins on the other side of the ring. The writer has experimented in regard to this matter and found a decided increase in thread breakages by working with thread wires out of

centre with the bobbins. While some threads would continue working for quite a time with a very inaccurate setting, other threads broke in a few seconds. Curiously enough the threads apparently remained up longer when the thread wires were set much too far forward, whereas they broke immediately when the wires were set an equal amount towards the back.

Another Make of Thread Board.

In another make of steel thread rail which the writer has examined, a still more radical departure from long established practice has been made, and we understand a good many of these are working in Wigan and District, and with most excellent results. In this example the long back rails which are hinged to the roller beam are made of strong wrought angle iron, and may be all turned up for doffing purposes by the usual handle and rod connection. Each metal thread rail is constructed in two pieces, one of which is hinged to the long angle iron rail. This first piece is bent downwards at the sides, and one side contains a sufficiently long slot. The second piece also is bent down at the sides, and is adjustably secured by a small setscrew to the No. 1 piece. The second piece, by means of the side slot can readily be adjustable to any requirements either towards or away from the roller beam, while the first piece is provided with a slot by means of which lateral or sideways adjustment may be obtained. Instead of the wire there is a slit cut in each of the No. 2 pieces terminating in a small round aperture for the thread.

The writer cannot help but conclude that steel or metal thread boards will become much more largely adopted in the future, since they make an altogether more mechanical job, can easily be adapted to requirements, are less liable to go wrong than wood rails, remembering that the consequence of defective and wrongly set boards and wires are so disastrous to good spinning and the production of good yarns.

Q. In what direction do the tin rollers of a ring-frame revolve, and why are guards sometimes needed for these rollers?

Direction of Tin Roller Revolution.

A. The inside or contact surfaces of the two tin rollers revolve in the same direction and may revolve inwardly from

the floor or lower side or outwardly at this point. Both methods are in use but most people have preferred the inwardly rotation from the floor or lower side.

Recently attention has been strongly directed to accidents happening to operatives with the floor side inwardly rotation, and various forms of guard have been more or less adopted as a protection, and special means of threading new spindle bands recommended therewith. The "push out" guard consists of a light roller placed beneath and between the tin rollers, and should an object of any kind attempt to pass upwards between the rollers the guard roller is thereby pushed against the opposite tin roller and is made to revolve in a direction which forces the object back into safety.

Some ring spinning mills have reverted to the inwardly rotation of tin rollers from the upper side as the best and easiest method of preventing accidents and satisfying the Inspectors.

Many ring-frames are so arranged in the top twist wheel slot that the twist wheel can be moved across the top of the frame and geared on the opposite side, while the driving belt is reversed so as to turn the frame in the opposite direction. After a frame has worked for some time some spinners have found this method to break spindle bands rather more and the operatives need to get accustomed to the reversed frames.

Q. Describe any mechanism occasionally used for delaying the start of the rollers momentarily when a ring-frame is started.

Roller Retarding Motion.

A. This is a motion for ring spinning frames that is becoming a little more used. Every one that has had anything to do with self-actor mules is well acquainted with arrangements for delaying the start of the rollers until after that of the carriage, or what is termed "the anti-snarling motions". There are many such devices, and most mules are equipped with one or other arrangement for the purpose, the necessity for their use being due to slackening of threads during the unlocking of fallers, aided by the use of bands for drawing the carriage out. The slotted internal disc is the favourite basis of most of these motions.

There is much less need for such a motion upon the ring-frame; but there are cases in which there is a tendency for snarling of the threads when a ring-frame is stopped and started so that in some weft frames the anti-snarling principle is now adopted. There are rival mechanisms for the purpose, some of them being connected to the tin roller shaft of the machine, and others to the twist carrier, which is much nearer to the rollers. On a mule the snarling motion is useful every draw the mule makes, but on the ring-frame it is only useful every time the machine is stopped and started, which is a very different thing, and may help to explain why these motions are not more in use on ring-frames.

Speed Wheel Retarder.

The whole of the mechanism is centred about the stud of the double twist carrier, and twist wheel. Really these two wheels are centred upon a stud which has a complicated and peculiar construction. The large twist carrier is driven in the usual manner from the tin roller shaft, and is connected to a sleeve or boss which revolves upon a long central spindle. At the inside extremities of the sleeve and centre spindle there is a clutch arrangement which a good deal resembles the internal disc arrangement of the mule. The sleeve drives the spindle by means of the clutch, and before a frame is started it is an easy matter to just arrange the clutch so that the start of the twist wheel spindle is delayed until after the other frame end wheels and the twisting spindles have made a start. The twist wheel spindle is secured to the twist wheel by a special pin and collar arrangement, which is quite convenient for making any desired changes in size of twist wheel. Naturally, any delay in driving the twist wheel represents a proportionate delay in starting the rollers. The writer has frequently noticed a tendency towards snarling upon a ring-frame when it is momentarily running slowly at stopping and starting times, and this explains the possible benefit of a roller retarding motion.

Q. Describe the special features of the cop building motion for spinning weft on the ring-frame.

Weft Frame.

A. The building motion is so arranged that the lifter for pin cops is moved about at a much quicker rate than for warp

yarn. The thinner cops, the smaller rings, and the fact of building the cops on thin paper tubes with a diameter of full cop not exceeding $\frac{7}{8}$ inch, are the factors which apparently require the quicker lifter traverse. In a special case the frame was making a good, well twisted yarn of about 26's counts, with a small twist wheel on. The twist frame occupied approximately 43 seconds for the up traverse, and about 15 seconds for the down movement, whereas the pin cop or weft frame only took seven seconds for the down traverse and 22 for the up movement. It will be noticed that the rate of traverse is substantially twice as fast for the weft as for the warp bobbin, and such a difference could be obtained by using a double worm for the weft, and a single worm for the twist with other things equal, in connection with the driving and working of the builder motion.

Weft and Paper Tube Spindles.

In some cases on twist frames paper tubes are used instead of the wood bobbins. To meet such cases the spindle may have a sleeve covering all the length of its blade, or as an equivalent a wood sleeve may be firmly secured to the spindle. The paper tube is lighter, and is more convenient for transit if twist yarn is required to be sent away in bobbin or cop form instead of being made into hanks, warps, or winding frame cheeses or bobbins. For pin cops intended for the shuttle very small diameter rings are used and the spindles are prepared for receiving either all through paper tubes, or else wood bobbins specially made of very small diameter. The question as to whether the thin wood tube or the small diameter paper tube will be best must be determined to suit any particular case.

Q. Give some particulars in regard to creels for ring-frames.

Creels.

A. Double row creels are customary on ring-frames owing to these machines being of the duplicate or double-sided type.

For single roving a 2-height creel and for double roving a 3-height creel.

A fine twist mule gauge of $1\frac{1}{4}$ inches only requires the same creeling space as the *double sided* ring-frame of $2\frac{1}{2}$ inch gauge,

but the 4-height single creel is often preferred for fine mules both on double roving. The gauge factor, however, keeps the creeling arrangements much the same for the rival machines.

Owing to female labour being used for ring-frames it is important to keep the creel height as low as convenient, so that the Birkenhead type of creel is often used for ring-frames although it is more costly.

In this type of creel a very deep but very narrow wood centrepiece is used, and a small finger is screwed to this centrepiece for the top of each skewer with a similar finger for the footstep.

By this means the foot of one skewer considerably overlaps the tip of the next lower one, thus reducing the height of the creel or bobbin box by 4 inches or so in a 2-height creel.

Either porcelain or glass footsteps may be used, and can be changed better than when allowing the skewers to revolve in an iron creel.

Increased steadiness is obtained if creel ends are used in addition to the round pillar stands.

Flat or table top creels are used in a few cases and permit better oversight by foremen, and give better natural lighting in dark rooms.

Steel creels and top and bottom boards are sometimes used and will not warp and are easily cleaned.

Ring Spinning *v.* Mule Spinning.

Q. What are the relative positions of mule and ring spinning?

A. Writing in 1915 we may say there are now approximately 140 millions of spindles in the world engaged in producing cotton yarns, and almost half of these are ring spindles.

In countries like America, where there has been a frequent scarcity of the more highly skilled labour for mules, and where there is always a tendency to adopt more automatic machinery, ring spinning is predominant.

In Lancashire there are now very many ring spinning frames spinning from coarse carded yarns up to 110's or finer in good combed yarns; but the mule is still far and away the predominant machine with us on practically all counts of yarn from the coarsest to the finest.

The skill of our overlookers and operatives, the splendid adaptability of the mule to varying conditions, its ability to spin on the bare spindle, and the fullness and elasticity of the yarn help to maintain the supremacy of the mule.

The immense space required for a pair of mules, the use of a travelling carriage, the complicated backing off, winding-on and cop shaping mechanisms are against the success of the mule.

It is in favour of high speeds of spindle on the ring-frame that each ring spindle revolves continuously in oil, and it is against high speeds on the mule that the latter is so frequently stopping, reversing, and then restarting. These factors counterbalance the disadvantage of carrying a bobbin, along with the use of the self-contained and gravity principles.

Q. What means are adopted to obtain extreme accuracy in the manufacture of rings for the ring-frame?

THE RINGS.

A. In many cases these are now stamped from the solid steel bar—an operation which the writer has witnessed—and in this way irregularities of structure are prevented, such as may possibly occur if rings are welded.

It is now customary to turn and polish the rings by automatic machinery, then to case-harden them very perfectly, and afterwards to impart a high degree of polish to the rings. Every ring is carefully tested in various ways and competent inspection of rings is an art of itself. Rings are tested for the slightest variation in size—say to 2 or 3 thousandths of an inch, for concentricity of flange, for hardness, for smoothness of finish and for roughness.

Q. 1910. Sketch and describe any mechanical appliance used for lifting all the thread boards of a ring-frame simultaneously for doffing purposes.

A. The thread boards are attached to the roller beams at D. Each thread wire is usually made of 8's or 9's wire and should be set over the centre of the spindle, on thread board, E, for each spindle, and a connected hinged piece, D, running the length of the frame. (See Fig. 97.)

By pulling at the handle, H, the link, G, pulls at the arm F, secured to shaft, A, and turns A round for a small portion

of a revolution. The links, C and C^1, are secured at their inner extremities to the slotted fingers, B, B, which are also secured to the shaft, A. Each link, C or C^1, at its outward end is secured to the long portion, D,D, of the thread boards, and DD extend on hinges the length of the frame on each side. The simple pulling of the handle, H, therefore lifts all the thread boards simultaneously ready for doffing, and H is catch at I until doffing is finished and the thread boards are put back into working position by the same handle. Each thread board may be separately lifted at E for piecing up or other purposes.

Q. 1910. Describe fully the construction of the traveller as used for ring spinning, and show by means of sketches how it is mounted on the ring. How is the traveller automatically cleaned during working, and what results if this operation is not satisfactorily performed? 24 marks.

A. The traveller of a ring-frame is a very small incomplete steel hoop, practically equal in size to the half of a small sewing needle flattened out and bent round into an incomplete circle or hoop. The ends are bent inwards in a manner which permits each traveller to be sprung or forced upon the specially formed flange of the ring after which the clips or bent ends prevent the thread from pulling the traveller off the ring. Travellers are graded in weight so that thicker and heavier travellers are used for stronger yarns

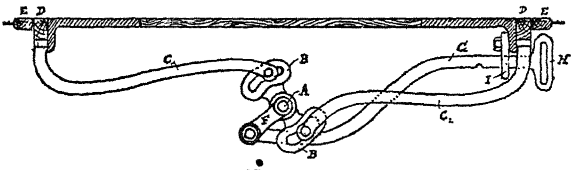


FIG. 97.

and coarser counts. The traveller in any case is very light, and is drawn round the ring at a high rate of speed by the yarn, the latter being always in contact with the traveller so that there is more or less tendency for the fly or fibre to adhere to the traveller. Any such accumulation of fibre upon the traveller would impede its free rotation round the ring and would impose too great a strain on the yarn, so that

dirty travellers would produce excessive thread breakage. To prevent this a small metal finger is secured to the ring rail near each ring at practically a writing paper clearance from the traveller. This knocks loose fibre off the traveller without touching the latter.

Q. 1909. Describe fully how the operations of twisting and winding are simultaneously performed on the ring-frame. How does the tapered character of the bobbin affect the process? 24 marks.

A. On a ring-frame the yarn and the bobbin drag the traveller quickly round the ring, but in proportion to the amount of cotton delivered from the rollers the yarn permits the traveller to lag behind the bobbin, and it is mainly by this loss of traveller speed over the bobbin speed that winding on is accomplished. The traveller not only influences winding on by losing speed, but also by the manner in which it holds the yarn in relation to the bobbin. Naturally the diameter of the bobbin at any particular time greatly affects the number of revolutions lost by the traveller, or, as we might say, gained by the bobbin.

The twisting operation is also influenced more or less by several conditions such as the delivery of roving, the speed of spindle relative to above, and the diameter of the bobbin. The bobbin is fast to the spindle, and twist is inserted by the rapid rotation of yarn and traveller round the bobbin and spindle due primarily to rotation of spindle. But the twists put into the yarn are not equal to the number of spindle revolutions, being reduced by whatever number of revolutions are lost by the traveller in order to wind on. If, for example, the spindles made 8000 revolutions per minute and the traveller lost 100 revolutions in winding on, then the twists would be equal, 7900. It must be noted that in this answer winding off at the next process is not considered at all.

When winding on at the thin part of the cone of the bobbin the traveller loses more revolutions than when winding on the base of the cone, so that there is a rather greater loss of twist when winding on small diameters than for large diameters. The rounded top of an empty bobbin facilitates the passing of the yarn round the top.

Q. What proportion of power is approximately required by the different parts of a ring-frame.

Division of Power at Ring-Frame

A well-known American firm have published the following table as the result of many tests :—

	Per cent
Power taken by tin rollers and bare spindles .	61
Power taken by draft rollers, gearing and traverse motion	11
Power taken by weight of bobbin and yarn .	11
Power taken by pull of travellers. . . .	17
Total	100

Excessively tight spindle bands may increase the power required by 15 to 20 per cent.

When using a tension scale to test the pull or tightness of spindle bands a pull of 2 lb. is considered correct, while a pull of 3 lb. is too much.

Q. Give a description of a method of making bobbins on a ring-frame, differing from the usual cop shape.

Roving-Frame Build of Bobbin.

It happens occasionally that the build or shape of bobbin produced on a roving-frame is required from a ring-frame instead of the ordinary cop-shaped bobbin. An example of this is found in making very hard twisted yarn or crape yarn in which it is sometimes required to unwind the yarn from the side of the revolving bobbin at the next machine, although side unwinding is often done with the ordinary build of bobbin.

The roving-frame builds a bobbin with a long parallel lift gradually and equally shortened at both ends.

It is easy to obtain this effect by setting out and arranging a few details of the copping motion differently.

Instead of the unequally divided cam for the cop-shape bobbin, a true heart-shaped cam is used so as to give equal up and down speeds to the ring rails. The heart-cam is given a good throw so as to produce a long lift sufficient to cover the whole required length of empty bobbin while a very slow speed is given to the cam and the lifter so as to wind the

thread coils very closely together since no open crossing coils are needed.

The ordinary shaper wheel effect for gradually raising the point of lifter traverse for cop shaping is not needed, but the shaper wheel is used for shortening the lift and producing the equal top and bottom cones on the bobbins. The gradual turning of the shaper moves the chain connection from long copping lever to lifter nearer and nearer to the fulcrum of the long copping lever and this has the natural effect of shortening the lifter traverse.

Q. What is the most radical alteration attempted in recent years in connection with drafting the cotton thinner?

LARGE DRAFT RING-FRAME.

A. Towards the end of 1913 and beginning of 1914 a great deal of attention was attracted to an invention by Mr. Casablanca, designed to dispense with most of the fly-frames and the repeated doublings and draftings so long in use between the card and spinning machine in ordinary cotton spinning.

A ring-frame of Howard & Bullough's make was put to work with this new invention at a mill at Sabadell, Cataluna, Spain, and an early description was posted to the present writer by one of his old students occupying the position of mill manager abroad.

The general features of the ring-frame were unchanged, the great differences being found in the absence of the ordinary back and middle pairs of drawing rollers and the substitution of short endless leather bands.

The ring-frame worked with a spindle speed of about 7300 revolutions per minute, used a 1-hank slubbing, and readily drafted this into yarn of 60's or finer at one operation. Each slubbing was brought from the creel between a pair of endless leather bands which delivered the cotton to the nip of the front rollers. Each band is mounted on a shaft and driven from the frame end in the same way as the draft rollers, and each band was about 1 inch width, and kept at sufficient tension to stop it from bagging.

It is undoubtedly a fact that very fair cotton yarn has been spun on this system—some of it has been sent to the

present writer—and very much finer counts than 60's have been thus spun.

At the time of writing it remains to be seen whether the trade will take up the idea commercially.

RING-SPINNING FRAME QUERY SHEET.

No. of Frames	No. of Spindles in Frame............
Space of Spindles	Length of Lift ....
Dia. of Spindle Warve..............	Dia. of Ring ....
Spindles to run Weft way............or	Twist way............
Revs. of Spindles per minute......	Revs. of Main Shaft per minute...
Dia. of Drum on Main Shaft	Dia. of Pulley on Tin Roller ......
One or two Tin Rollers..............	Dia. of ditto..............
Numbers of Yarn to be spun...	
Twist per inch	Three Lines of Rollers..............
Dia. of Front Bottom Roller	Ditto Top Roller uncovered.........
,, Middle ,, ...	,, ,, ,, ...
,, Back ,, ...	,, ,, ,, ...
The Rollers are weighted as follows :—...	
....	
Patent Anti-balloon Plates........	Kind of Cotton to be worked .....

Q. Sketch and explain how a ring-frame is usually driven from the line or counter-shaft.

A. In many cases a half-crossed belt is used to connect the top shaft with the tin roller shaft of a ring-frame as on a fly-frame, but this is not very satisfactory on a ring-frame because of the high spindle speed required and the very large diameter line shaft drum necessary.

Rope driving is also sometimes adopted from line shaft to tin roller shaft, and a special kind of grooved pulley adopted to enable the belt to be moved across the fast and loose pulleys.

The steady load of a ring-frame and the high spindle speed make it a convenient machine for individual electric motor driving, and many ring-frames are now driven in this manner.

The favourite method is shown in the accompanying two views of ring-frame drive (fig. 98).

The large drum, C, on line shaft drives by a long belt and over the gallows carrier pulleys, GG, down to the fast and loose pulleys, M, on one of the tin roller shafts. This method gives long and powerful driving belt which bites squarely on the driving drum, C, and the driven pulleys, M. It has the disadvantage of extending partly over the creels and rollers,

thus making a little dirt, often breaking bobbins when it tumbles down, and being a little troublesome to put on again.

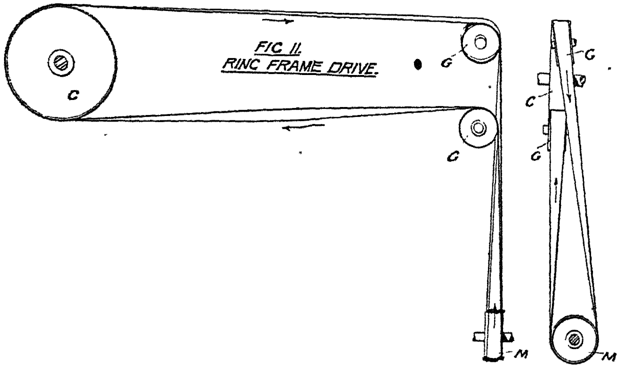


FIG. 98.

Q. What conditions do you think are likely to give best results in regard to separators or anti-ballooning appliances, and describe a recent arrangement?

ITEMS RELATING TO SEPARATORS.

A. Speaking without reference to the question of first cost. The separators should be of the thin, vertical type, and preferably electro-plated to prevent fly from adhering thereto. They should move upwards at the same time as the ring rail, either at the same or at a slower rate, so that the length of thread possible for ballooning shall be shortened both below and above the length of the separator. They should be capable of turning backwards out of action at one operation if required, and should be capable of lifting out easily without disturbing any other part. They should be absolutely smooth, and without any sharp corners, and should project far enough forward to prevent threads from ballooning round the front. Some of the best of the separators appear to be thicker than they ought to be, and one wonders whether it would not be feasible to have them punched out of thin sheet steel by specially prepared punches, and get

sufficient strength with about the thickness one is accustomed to see in this latter kind of material.

Writing in 1915, one of the most recent forms of separator has been given the name of the "Finger Space Separator," and is made by a well-known firm of textile machinists, which has long specialised in the construction of ring-spinning frames. The particular aim of the new separator is to give more fingering space for the operatives, thus removing one of the chief objections to separators, whilst retaining the maximum working benefit from the use of separators. The finger space separator is designed so that in the case of any one spindle the separator on one side of this spindle will act on the upper portion of the ballooning thread, while the separator on the other side of the same spindle will act on the lower portion of the balloon. The usual practice is to make no distinction whatever of this kind. It has become a practice with the deep loop separators to electro-plate them so as to obtain a high polish, and this practice is followed in the case of the finger space separators. The new separator is made to give the maximum finger space partly through the adoption of the above principle, and also its construction with a concave and a convex side. In addition the construction is such that the separator forms a kind of guard for the knuckles of the operative's fingers. The makers apparently have sufficient confidence in the new separator to apply it on approval, and have taken out both British and foreign patents. Two forms of separator are shown in figs. 89, 89A, the deep ones 89A being made of any size required.

Remarks.

Snarls in the yarn should be caught by the nicks in the thread wires or else by some small special device.

Travellers tend to become fastened together in the boxes or packages and cause a little wastage and trouble.

A ring traveller magazine may be used if required and fixed on a table, and will discharge travellers singly as wanted.

TECHNOLOGICAL EXAMINATIONS, 1915.

GRADE II.

Saturday, 1st May, 2.30 to 6.30 p.m.

1. Describe how the slivers from the card are formed into a lap at the sliver lap machine. Describe also the mechanism used to stop the machine when any of the slivers fail.

2. Describe how during the process of combing the fibre is treated by the needles of the cylinder and the top comb respectively. Does any portion of the fibre escape treatment by the cylinder needles? If so, state which, and describe how this portion is eventually combed.

3. State briefly the principal differences in construction between the Heilmann and Nasmith combing machines. Describe how these differences affect the productive capacity of each machine respectively, giving reasons in each instance.

4. State how the methods of preparing rovings on the fly frames differ when intended for the production of coarse and fine counts of yarn respectively. Describe fully how these differences are necessitated by the character of the material and the results required in each instance.

5. Describe in sequence the operations to be performed in doffing a fly frame. State why the bottom cone drum is lifted out of contact with the belt previous to doffing, and describe in detail how the various motions are adjusted for the commencement of the next set of bobbins.

6. State why it is necessary to use a differential motion on a fly frame, and describe in detail how it accomplishes its objects. You may select for your answer any form of motion with which you are acquainted.

7. Describe, with sketches, the construction of the bobbin used on fly frames fitted with long collars, and explain how they are supported and driven. State what would be the

effect of using bobbins of variable diameter, and how these would be denoted when starting the frame.

8. State in order of importance the essential features of good yarn, and explain fully why they are essential. Indicate briefly the methods employed to develop these features to the fullest extent in practice.

9. Explain in detail the manner in which the fibres of a yarn are twisted together by the action of the mule spindle during spinning, and illustrate your answer by sketches. Describe also how variations in the diameter of the yarn at different positions affect the distribution of the twist, giving full reasons for your answer.

10. If a straight-edge be applied to the long incline of a mule copping-rail, state approximately to what extent its profile will be found to vary from a straight line. State the objects of this method of construction, and the reasons which make it necessary to adopt it.

11. Sketch and describe the arrangement of the gear train from the rim shaft to the back shaft of a mule, indicating the change places and stating the functions controlled by each. State the reasons why the back shaft scrolls are reduced in diameter at the ends, and what advantages are derived from this form of construction.

12. Describe the mechanism used on a mule for moving the down belt on and off the fast pulley on the rim shaft. State what differences would be made in this mechanism under each of the following circumstances: (*a*) mules using the speed wheel or back-change wheel as the twist change place, and (*b*) mules fitted with twisting motions.

13. Describe the "click spring" arrangement for operating the winding catch of a mule, explaining fully how the catch is engaged and disengaged and kept out of action during the period of backing-off. State the direction of rotation of the winding wheel relative to the catch during the action of backing-off, and explain how a slack winding chain may cause the winding catch to interfere with the backing-off action.

14. Give a brief explanation of the various forces which act upon the length of yarn between the traveller and the thread guide of a ring frame to cause the action known as balooning, and state the advantages and disadvantages of this action. State to what extent the shape and size of the

balloon varies throughout the build of the bobbin, and to what causes these changes are due.

15. Describe how the cam for actuating the ring rail of a ring-frame is driven from the driving shaft of the machine. Is the speed of the ring rail relative to the speed of the front roller affected by an alteration in the size of the twist wheel? If not, state at what position this ratio may be altered.

16. State the factors which determine the largest diameter of full bobbin which can be made in a given diameter of ring on the ring-frame, illustrating your answer by means of sketches. Describe the means used on the machine for controlling the diameter of the full bobbin, and state how this may be increased or decreased as may be necessary.

17. A roving frame of 200 spindles long is worked at a spindle speed of 1050 revs. per min., and the twist inserted into the roving is three turns per inch. The production of roving in 48 hours' actual working is 550 lbs. Find the hank roving that is being made.

18. A comber of 8 heads is required to produce a sliver of ·166 hank, and the mechanical drafts in the machine are arranged as follows:—From the lap rollers to the front calender block on the table, 4·51, and from this calender block to the coiler, 6·66. The waste to be extracted is 20 per cent. Find the weight per yard in grains of the laps to be fed to the comber. State also what weight per yard in grains the resultant sliver would become if the percentage of waste extracted were reduced to 15, and drafts and lap weights remained the same.

THE END.

INDEX.

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